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THE FERTILITY RELATIONSHIP OF ABACÁ WITH PACOL AND CANTON [1]

DIOSCORO L. UMALI AND CARLOS G. VALDEZ
Of the Department of Agronomy

WITH SEVEN TEXT FIGURES

Quisumbing and Elayda [2] noted that pacol, *Musa errans* (Blanco) Teodoro, and canton, *Musa cantoni*, whose external features and growing habits are similar to abacá, *Musa textilis* Née, have many

Fig. 1.—Left, a stool of *Musa textilis* Née var. *Maguindanao* (Saleeby); center, a hill of canton with a bunch of fruits; and right, a hill of pacol with a bunch of fruits and the heart.

[1] Experiment Station Contribution No. 1615. From the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 1766.

[2] QUISUMBING, E., AND I. ELAYDA. 1926. A brief survey of conditions affecting agriculture in the Bicol regions. Philippine Agriculturist 14: 457–471.

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desirable characters which can be bred into abacá. In order to find out if it is possible to hybridize abacá with pacol and canton, which are immune to bunchy-top and mosaic diseases, and produce hybrid plants which are resistant to these diseases and at the same time possess the desirable fiber qualities of abacá, a study was made of the flower structure, the blooming and fruiting habits, and the fertility relationship of abacá, canton, and pacol.

The investigation was conducted in the abacá, canton, and pacol nursery of the College and in the Plant Breeding laboratory of the Department of Agronomy from December, 1949, to October, 1951.

MATERIALS AND METHODS

Abacá. The variety Maguindanao (fig. 1, left) used in the study was characterized by Vista [3] as follows:

> This variety produces 10–17 plants to a hill but 4–5 are medium and 4–8 are small, spreading in the hill; fast grower, began flowering at the age of 1 year and 4½ months after the sucker is transplanted, of lowland habitat. False stem is 3.30–4.30 m. high, 20–22 cm. diameter at top; this grows into a very big plant and as tall as 5.5 m. if grown on heavy soils. This variety is from Lamao Experiment Station.
>
> This variety is cultivated throughout Davao. It produces few roots so it is easily affected by drought and easily fallen by wind.

Canton. The plant is similar to abaca in external features and in growth habits (fig. 1, center) but may be distinguished from it by the pinkish coloration of the lower surface of the leaves. The fruits resemble those of abacá but are thinner and seedless. There seems to be two kinds of canton: one with dark brown spots on the leaves and with green stem and the other without these distinguishing characteristics. The latter, however, has not been clearly identified to the present.

The origin of canton is not known. It is suspected to be a hybrid between banana and abacá. A vigorous and fast-growing plant, canton is drought-resistant and thrives well even in places where abacá would not grow profitably. It does not need replanting, for it continues to grow and produce large and healthy stalks around the old ones. When the old stalks die and the corm rots, the center of the stool becomes open.

Pacol. This plant resembles the *Musa errans* (Blanco) Teodoro var. *Butuhan* in height and other plant characters (fig. 1, right). It is characterized by a tall, massive, dark green stalk. The leaves may be distinguished from those of canton and abacá by their large blades covered with white bloom. The fruits are plump, hexagonal, about 10 centimeters long, and are close to each other, forming a compact hand. Pacol is drought-resistant and tolerant of weeds.

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[3] VISTA, TOMAS ISLES. 1920. A study of the classification of abacá varieties. (Thesis presented for the degree of Master of Science, College of Agriculture. Unpublished.) *Cited in* Philippine Agriculturist 12: 143–152.

Pollination. Ferrer and Espino [4] found that when the inflorescences of abacá were bagged, the fruits failed to develop, and after two months the inflorescences dried up. They found that self-pollination could not occur because the female flowers at the base of the inflorescence matured much earlier than the male flowers at the terminal or upper end of the flower stalk.

The inflorescences of the plants under study were bagged with wax paper a day before the flowers opened. Likewise, the male flowers were bagged a day before anther dehiscence. Emasculation was unnecessary because the three species are monoecious.

Crosses performed. To determine the fertility relationships of the three species, the following crosses were made: (1) abacá × canton, (2) canton × abacá, (3) abacá × pacol, (4) pacol × abacá, (5) canton × pacol, and (6) pacol × canton.

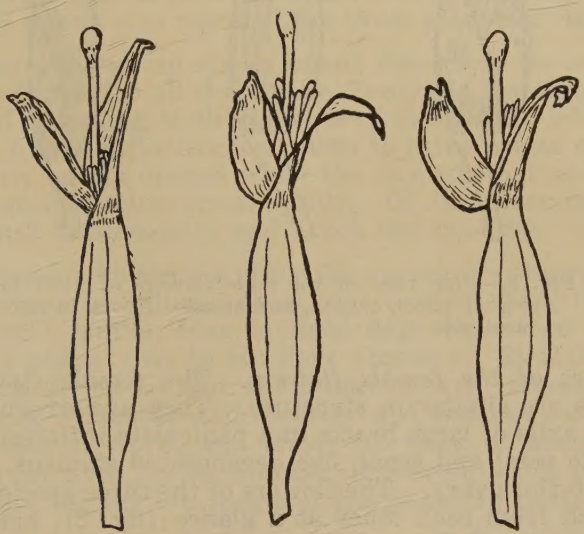

Fig. 2.—Side view of the female flowers of (left to right) abacá, canton, and pacol. About ½ natural size.

Care of the pollinated flowers. After pollination, the plants were labelled for weekly observations.

Pollen examination. Immediately after anther dehiscence, the pollen grains were gathered and examined with the low power objective of the microscope.

[4] FERRER, L. G., AND R. B. ESPINO. 1923. A study on the germination of abacá seeds. Philippine Agriculturist 12: 101–109.

RESULTS AND DISCUSSION

Position of the male and female flowers on the spike. The inflorescence of each of the three species of *Musa* consists of a rachis (bunch) bearing clusters (hands) of female and male flowers. These clusters of different ages are covered with brightly colored bracts. The flowers are unisexual. The female is located at the basal half of the inflorescence and the male, at the terminal portion. The floral spikes of the three species are proterogynous.

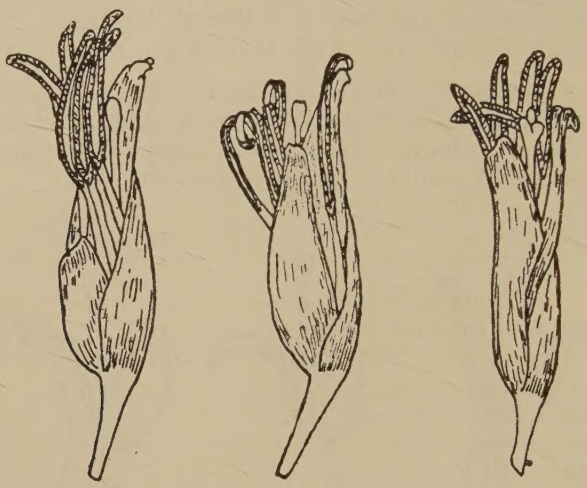

Fig. 3.—Side view of the male flowers of (left to right) pacol, canton, and abacá. About ½ natural size.

Structure of the female flowers. The female flowers of the three species are similar in structure. They are irregular and are borne in the axils of large bracts in a paniculate inflorescence. They have a single petal and sepal, five degenerated stamens, and a well-developed inferior ovary. The flowers of the three species were hard to distinguish from each other at a glance (fig. 2), but when they were examined carefully, a difference in the length of the stamens was noted. Measurements of fifty stamens showed that those of canton were the longest (45.1 ∓ 0.52 mm.), those of pacol were next (34.2 ∓ 0.81 mm.), and those of abacá, the shortest (20.1 ∓ 0.12 mm.).

Structure of the male flowers. The male flower can be distinguished from the female by the degenerated and nonfunctional pistil, the reduced size of the ovary, and the large and well-developed stamens. Like the female flower, it has one sepal, one petal, and five stamens.

The male flower of abacá can be distinguished easily from those of canton and pacol by its lobed stigma (fig. 3). The flower

of canton, on the other hand, can be distinguished from that of pacol by the backward curling of its stamens and its scarce pollen supply at the time of dehiscence. The stamens of pacol do not curl backwards and contain an abundance of pollen grains.

Blooming and fruiting habits

Emergence and opening of flower bracts. The length of time from the emergence of the flower stalk to the full opening of the first cluster of female flowers varied slightly according to the species. On the average, abacá female flowers bloomed in eight days, canton in seven days, and pacol in five days. In the three species the lifting of the bracts occurred between six o'clock in the afternoon and seven o'clock of the following morning. It was noted, however, that when the temperature was high during the day, the bracts commenced to lift at about six o'clock in the afternoon. When the day was cool and cloudy, the opening was delayed until seven o'clock the next morning. This relation between weather conditions and the time of lifting of the bracts was noted in the three species of *Musa* studied.

Duration of blooming of the female flowers in the inflorescence. The length of time for all the female flowers in the inflorescence to bloom varied according to the number of bracts that lifted in a day and the size of the inflorescence. Two to three bracts of pacol, one of abacá (two bracts opened when the day was hot and dry), and generally, two of canton opened daily. Of the three species, pacol has the largest inflorescence and abacá the smallest.

The duration of blooming of the female flowers observed throughout the year was as follows: pacol, five to eight days (based on 30 inflorescences); canton, four to eight days (based on 26 inflorescences); and abacá, four to six days (based on 43 inflorescences). The blooming period for the three species was longest during the cool months of December and January and shortest during the hot months of March, April, and May. No peak of blooming of the flowers was observed, as the number of flowers which opened every day was about the same throughout the blooming period.

Order of blooming of the female flowers. In all the three species, the uppermost cluster of female flowers located at the base of the flower stalk opened first. Blooming then continued downward in a fairly regular manner, each cluster following the one above. In general, the flowers in the cluster opened at the same time.

Blooming of individual female flowers. Blooming started with the opening of the sepals, followed by that of the petals. With the opening of the corolla, a white sticky secretion appeared on the stigma which had become exposed. As the secretion accumulated, the stigma changed in color from white to dark brown. The female flower opened fully in 20 to 45 minutes and reached the stage of maximum receptivity in about an hour.

Unlike in other plants, the sepals and petals of abacá, canton, and pacol do not close after blooming; they remain open until they fall off.

Duration of receptivity of the stigma. The receptivity of the stigmas was judged by their color and condition. At the time of receptivity, the stigmas, which originally were white, became dark brown and well-covered with a viscid, mucilaginous secretion. This change was noted in abacá, canton, and pacol.

To determine the time of greatest receptivity of the stigmas, the three species were close-pollinated by applying as much pollen as they could hold from six o'clock in the morning to six o'clock in the afternoon and again at seven o'clock of the following day. The number of seeds formed with each pollination was used as the criterion for judging the receptivity of the stigma. Absence of seeds in the fruit formed was taken as an indication of the unpreparedness of the stigma to receive the pollen grains at the time of pollination.

It may be noted in table 1 that at six o'clock in the morning, although the flowers of pacol were already open, the stigmas were not yet receptive. In general, receptivity commenced from seven to eight o'clock in the morning and reached its height from eleven to twelve noon, as shown by the number of seeds formed in the fruits of flowers pollinated at that time. The least number of seeds was obtained from flowers pollinated from five to six o'clock in the afternoon. Pollination was no longer effective when done from seven to eight o'clock of the following morning.

As shown in table 2, the stigma of pacol was most receptive to pollen from nine to ten o'clock in the morning. Inasmuch as canton was found to be self-and cross-infertile, the time of highest receptivity of its stigma could not be determined.

Blooming of the male flowers. Although the number of bracts that lifted in a day was about the same for the female and male flowers of abacá, canton, and pacol, the duration of blooming of the male flowers was longer than that of the female because, on the average, there were twelve times more male than female flowers. The number of hands and the number of days of blooming of the male flowers were as follows:

SPECIES	NO. OF HANDS	NO. OF DAYS
Abacá	220–285	106–136
Pacol	200–250	96–117
Canton	205–270	102–135

It may thus be seen that the male flowers could produce sufficient pollen for female flowers in twelve different inflorescences. Practically all of the female flowers of abacá and pacol, as indicated by the seediness of their fruits, were pollinated.

Like the receptivity of the stigma, the time of dehiscence of the anther also depended on weather conditions. Anther dehiscence oc-

curred early in the morning on dry and sunny days and late in the afternoon on cloudy and humid days. The periods of anther dehiscence were as follows: abacá, from 7:00 a.m. to 4:00 p.m.; canton, from 7:30 a.m. to 2:00 p.m.; and pacol, from 7:30 a.m. to 3:00 p.m.

In abacá, pacol, and canton, the pollen grains are released by the anthers immediately after the opening of the corolla. When stored under ordinary conditions, the pollen grains lose their viability after 24 hours (table 3).

The length of time from pollination of flower to maturity of fruit. The average number of days from the pollination of the flower to the maturity of the fruit was 149.0 days for pacol and 150.2 days for abacá (tables 4 and 5). The ripening of the fruits of the first hand was taken as the indication of maturity. The fingers of the inflorescence did not ripen uniformly; the fruits at the base of the bunch were expected to mature first because they developed from flowers that were pollinated first.

It was also noted that young abacá fruits from unpollinated flowers shrank, dried, and dropped off. The fingers of unpollinated canton and pacol flowers did not drop off, although they remained green and small until the plants died.

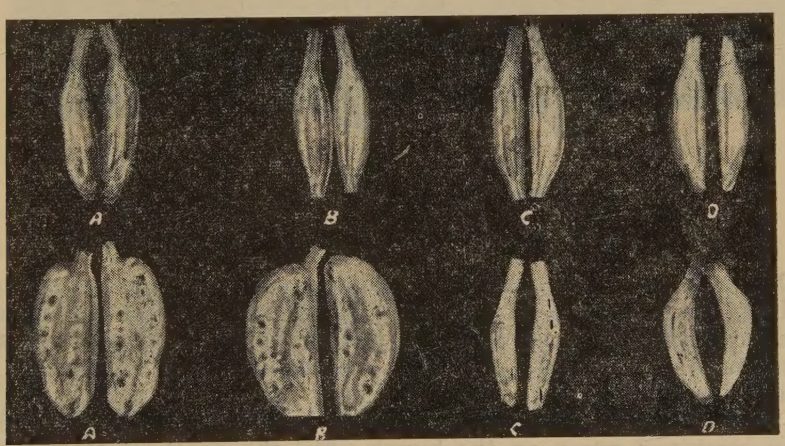

Fig. 4.—Fruits of the crosses cut open to show the seeds. Upper row: canton × abacá—A, open-pollinated; B, close-pollinated; C, pollinated with abacá pollen; D, control, no pollination. Lower row: abacá × canton—A, open-pollinated; B, close-pollinated; C, pollinated with canton pollen; D, control, no pollination.

Fertility relationship of abacá, pacol, and canton. With the knowledge of the flower structures and blooming habits of abacá, pacol, and canton, appropriate breeding techniques were devised for their cross-pollinations.

Abacá × canton

Although canton is a sterile species and produces fruits without seeds, crosses between it and abacá were attempted to see whether abacá could be stimulated to fruit and develop seeds with suitable breeding techniques, such as pollination at the bud stage, pollination after reducing the length of the pistil, and the use of a mixture of abacá and canton pollen with abacá as seed parent. It was thought possible that among the canton pollen grains used in pollinating abacá flowers, one or a few with unreduced chromosome number might be present. Sterile plants with nonfunctional pollen occasionally produce unreduced pollen grains that are fertile because of some abnormalities in microsporogenesis. Thus, Cheesman (1933) successfully crosed a fertile variety of *Musa malaccensis* Ridle (seed parent) and the sterile Gros Michel, and he believed that the few seeds produced on *Musa malaccensis* were due to some unreduced pollen of Gros Michel. There are other cases of hybrid bananas produced from sterile species as a result of the doubling of the chromosomes in the male component. It was believed possible that the

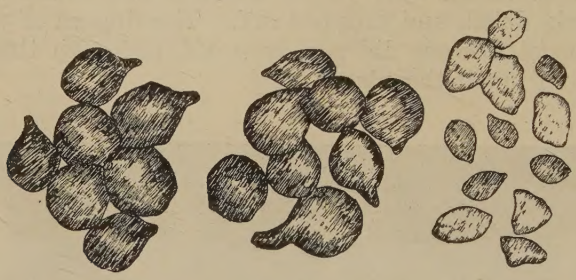

Fig. 5.—Camera lucida drawings of pollen grains of (left *to* right) abacá, pacol, and canton. About 25×.

development in canton of some aposporous female gametes would result in the formation of fertile ovules which could be fertilized by the abacá pollen. However, after reciprocal pollination of eight inflorescences of abacá and eleven of canton, involving a total of 1,842 female flowers, no seeds were produced on either species (fig. 4). The fruits formed from the canton flowers pollinated with abacá pollen remained green on the bunch until the death of the plant.

To determine why the cross of abacá and canton failed to produce seed, the pollen grains of the two plants were studied. The abacá pollen grains were dark, round, plump, uniform in size and shape, and had an average diameter of 120 microns (fig. 5). The pollen grains of canton were very variable in size and irregular in shape. Many of them were empty, and the number of sound grains was small. The writers believe that this abnormal condition of the canton accounted for their failure to fertilize the ovules of abacá.

Cheesman and Larter [5] of the St. Vincent Botanic Garden in Trinidad, British West Indies, reported an abacá clone which did not cross readily with other species of *Eumusa* because of the difference in chromosome numbers.

Abacá × pacol

Pacol is a fertile species which forms seedy fruits when its flowers are close-pollinated. Its seeds are viable and germination is as high as 75 per cent. Its pollen grains are plump, sound, and uniform (fig. 5).

When abacá was used as the seed parent, only 13 fruits formed from five bunches which developed normal fruits with seeds (fig. 6,

Fig. 6.—Fruits of the crosses cut open to show the seeds. Upper row: pacol × abacá—A, open-pollinated; B, close-pollinated; C, pollinated with abacá pollen; D, control, no pollination. Lower row: abacá × pacol—A, open-pollinated; B, close-pollinated; C, pollinated with pacol pollen; D, control, no pollination.

lower row). However, unlike the fruits formed from unpollinated flowers and flowers pollinated with canton pollen, the undeveloped fruits of abacá from flowers pollinated with pacol pollen did not drop off the hands. The 13 fruits of abacá produced 47 hybrid seeds which were planted immediately after harvest. So far, only three viable seedlings have grown from this bunch of F_1 seeds.

As shown in table 6, all the close-pollinated flowers of abacá formed fruits, but only 77.8 per cent had seeds. When pacol pollen was used, the average fruit development was 5.5 per cent.

When pacol was used as the seed parent, all the pollinated flowers formed fruits; only 90.7 per cent produced plump, round fruits with

[5] CHEESMAN, E. E., AND L. N. H. LARTER. 1935. Genetical and cytological studies of *Musa*. III. Chromosome numbers in the Musaceae. Jour. Genet. 30: 31–52.

seeds (table 7 and fig. 6, upper row). There was 100 per cent fruit formation among the close-pollinated flowers. Both abacá and pacol pollen were efficient for inducing fruit formation. From the 60 fruits resulting from this cross, 189 hybrid seeds developed, but so far, this bunch of F_1 seeds has produced only one viable seedling.

Pacol showed evidence of fertility relationship to abacá, inasmuch as the cross between the two species produced some viable seeds.

Fig. 7.—Fruits of the crosses cut open to show the seeds. Upper row: pacol × canton—A, open-pollinated; B, close-pollinated; C, pollinated with pacol pollen; D, control, no pollination. Lower row: canton × pacol—A, open-pollinated; B, close-pollinated; C, pollinated with canton pollen; D, control, no pollination.

Pacol × canton

These two species are reciprocally incompatible. Four bunches of pacol (576 flowers) were pollinated with canton pollen and not a single fruit developed (fig. 7, upper row). The undeveloped fruits remained green and persisted on the peduncle until the mother plants died.

Not one of the fruits formed from three bunches of canton (468 flowers) pollinated with pacol pollen grains produced seeds (fig. 7, lower row). Practically all of the close-pollinated pacol flowers formed fruits with abundant seeds. The result indicates that pacol, which is a fertile species, is not compatible with canton.

SUMMARY

1. Of the three breeding stocks used, abacá and pacol are sexually reproductive; canton, on the other hand, is sterile.

2. The female flowers of the three species are similar in structure. They are irregular and are borne in the axile of large bracts in a paniculate inflorescence. Each flower has a single sepal and petal, five degenerate stamens, and a well-developed inferior ovary. On close examination, the flowers of the three species can be recog-

nized from one another by the length of the stamens. Those of canton were the longest, 45.1 ∓ 0.52 mm.; pacol next, 34.2 ∓ 0.81 mm.; and abacá, the shortest, 20.1 ∓ 0.12 mm.

3. The male flower of the three species can be distinguished from the female by its degenerate and nonfunctional pistil, reduced size of the ovary, and large and well-developed stamens. The male flower of abacá can be easily distinguished from that of canton or pacol by its lobed stigma. The flower of canton, on the other hand, is readily differentiated from that of pacol by the backward curling of its stamens and its scanty pollen supply at the time of dehiscence. The stamens of pacol do not curl backwards and contain an abundance of pollen grains.

4. There was a slight variation in the time of opening of the flower bracts, duration and order of blooming of the female flowers in the inflorescence, duration of receptivity of the stigmas, duration of blooming of the male flowers, and the time of dehiscence of the anthers of abacá, pacol, and canton. Pollination was conveniently effected because the time of anther dehiscence of all the species fell within the duration of receptivity of their stigmas.

5. Unlike the pollen grains of pacol and abacá, those of canton are variable in size, irregular in shape, and mostly transparent. Canton has few sound pollen.

6. Canton was incompatible with either abacá or pacol. On the other hand, reciprocal crosses between abacá and pacol produced some viable hybrid seeds.

TABLE 1

Close-pollination of pacol at different hours of the day

INFLORESCENCE	TIME OF POLLINATION	NO. OF HANDS POLLINATED	NO. OF FLOWERS IN HAND	AV. NO. OF SEEDS FORMED IN A FRUIT
I	6–7 a. m.	1	12	0
	7–8 a. m.[a]	1	12	92.66
	7–8 a. m.	1	13	38.68
	9–10 a. m.	1	13	41.68
	11–12 a. m.	1	12	56.66
	1–2 p. m.	1	12	48.32
	3–4 p. m.	1	12	18.16
	5–6 p. m.	1	13	0
	7–8 a. m.[b]	1	12	0
II	6–7 a. m.	1	12	0
	7–8 a. m.[a]	1	12	104.16
	7–8 a. m.	1	13	34.66
	9–10 a. m.	1	13	43.84
	11–12 a. m.	1	13	62.92
	1–2 p. m.	1	12	55.66
	3–4 p. m.	1	12	24.50
	5–6 p. m.	1	13	14.14
	7–8 a. m.[a]	1	13	0
III	6–7 a. m.	1	12	0
	7–8 a. m.[a]	1	11	83.27
	7–8 a. m.	1	13	28.14
	9–10 a. m.	2	25	44.08
	11–12 a. m.	2	26	43.60
	1–2 p. m.	1	12	43.50
	3–4 p. m.	2	24	29.50
	5–6 p. m.	1	12	17.16
	7–8 a. m.[b]	1	12	0
IV	6–7 a. m.	1	12	0
	7–8 a. m.[a]	1	12	94.00
	7–8 a. m.	1	12	32.82
	9–10 a. m.	1	12	55.10
	11–12 a. m.	1	13	60.92
	1–2 p. m.	1	13	52.46
	3–4 p. m.	1	13	31.68
	5–6 p. m.	1	12	19.32
	7–8 a. m.[b]	1	12	0
V	6–7 a. m.	1	13	0
	7–8 a. m.[a]	1	12	80.16
	7–8 a. m.	1	13	38.64
	9–10 a. m.	1	13	28.00
	11–12 a. m.	1	12	50.00
	1–2 p. m.	1	12	34.32
	3–4 p. m.	1	11	33.96
	5–6 p. m.	2	26	11.46
	7–8 a. m.[b]	1	12	0
VI	6–7 a. m.	1	12	0
	7–8 a. m.[a]	1	13	92.76
	7–8 a. m.	1	13	28.92
	9–10 a. m.	1	12	42.50
	11–12 a. m.	1	12	67.66
	1–2 p. m.	2	26	39.62
	3–4 p. m.	2	25	26.00
	5–6 p. m.	1	13	11.92
	7–8 a. m.[b]	2		0

[a] Flowers were not bagged to allow open pollination. [b] Pollination the following morning.

TABLE 2

Close-pollination of abacá at different hours of the day

INFLORESCENCE	TIME OF POLLINATION	NUMBER OF HANDS POLLINATED	NUMBER OF FLOWERS IN HAND	AV. NO. OF SEEDS FORMED IN A FRUIT
I	6–7 a. m.	1	6	0
	7–8 a. m.[a]	1	7	92.42
	7–8 a. m.	1	7	54.44
	9–10 a. m.	1	9	80.63
	11–12 a. m.	1	11	56.00
	1–2 p. m.	1	9	52.22
	3–4 p. m.	1	10	41.10
	5–6 p. m.	1	9	18.33
	7–8 a. m.[b]	1	11	0
II	7–8 a. m.[a]	1	10	78.30
	7–8 a. m.	1	10	49.60
	9–10 a. m.	1	12	74.25
	11–12 a. m.	1	11	61.10
	1–2 p. m.	1	12	54.08
	3–4 p. m.	1	10	47.80
	5–6 p. m.	1	10	32.12
	7–8 a. m.[b]	1	10	0
III	6–7 a. m.	1	10	0
	7–8 a. m.[a]	1	11	79.18
	7–8 a. m.	1	11	53.09
	9–10 a. m.	1	10	75.60
	11–12 a. m.	1	12	56.15
	1–2 p. m.	1	10	56.30
	3–4 p. m.	1	11	41.72
	5–6 p. m.	1	11	24.81
	7–8 a. m.[b]	1	10	0
IV	6–7 a. m.	1	10	0
	7–8 a. m.[a]	1	10	80.20
	7–8 a. m.	1	11	56.36
	9–10 a. m.	1	11	72.18
	11–12 a. m.	1	12	67.16
	1–2 p. m.	1	11	51.27
	3–4 p. m.	1	10	48.20
	5–6 p. m.	1	12	34.33
V	7–8 a. m.[b]	1	11	88.09
	7–8 a. m.	1	11	54.81
	9–10 a. m.	1	10	78.40
	11–12 a. m.	1	11	64.81
	1–2 p. m.	1	12	60.33
	3–4 p. m.	1	11	40.54
	5–6 p. m.	1	10	27.40

[a] Flowers were not bagged to allow open pollination.
[b] Pollination the following morning.

TABLE 3

Average number of seeds formed using pollen of different ages

SPECIES	AVERAGE NUMBER OF SEEDS IN A FRUIT		
	1 hour	12 hours	24 hours
Abacá [a]	52	2	0
Canton	—	—	—
Pacol [b]	108	5	0

[a] Abacá, based on 60 fruits.
[b] Pacol, based on 48 fruits.

TABLE 4

Length of time between pollination and maturity of pacol fruits

BUNCH NUMBER	DATE			DAYS OF MATURITY
	Pollination began	Pollination completed	Ripening of first hand	
I	May 13, 1950 [a]		Oct. 12, 1950	152
II	June 1, 1950	June 8, 1950	Oct. 28, 1950	149
III	June 17, 1950	June 24, 1950	Nov. 20, 1950	156
IV	June 19, 1950	June 26, 1950	Nov. 23, 1950	157
V	Oct. 30, 1950	Nov. 6, 1950	March 20, 1950	141
VI	Nov. 11, 1950	Nov. 18, 1950	March 30, 1950	139
			Average ...	149

[a] Open pollination.

TABLE 5

Length of time between pollination and maturity of abacá fruits

BUNCH NUMBER	DATE			DAYS OF MATURITY
	Pollination began	Pollination completed	Ripening of first hand	
I	Jan. 27, 1950 [a]		June 21, 1950	145
II	Feb. 28, 1950	March 6, 1950	July 28, 1950	150
III	March 5, 1950	March 13, 1950	Aug. 6, 1950	154
IV	March 6, 1950	March 13, 1950	Aug. 4, 1950	154
V	April 10, 1950	April 19, 1950	Sept. 5. 1950	148
			Average ...	150.2

[a] Open pollination.

TABLE 6

The cross between abacá (seed parent) and pacol

BUNCH NUMBER	NUMBER OF FLOWERS CLOSE-POLLINATED	NUMBER OF FLOWERS POLLINATED WITH PACOL POLLEN	NUMBER OF FRUITS FORMED	NUMBER OF FRUITS DEVELOPED	PERCENTAGE OF FRUITS DEVELOPED [a]
I	8	58	8 5	8 2	100 3.41
II	5	63	5 20	5 6	100 9.52
III	7	50	7 8	6 2	85.6 4.00
IV	7	65	7 7	2 3	100 4.61

[a] Based on number of flowers pollinated.

TABLE 7

The cross between pacol (seed parent) and abacá

BUNCH NUMBER	NUMBER OF FLOWERS CLOSE-POLLINATED	NUMBER OF FLOWERS POLLINATED WITH ABACA POLLEN	NUMBER OF FRUITS FORMED	NUMBER OF FRUITS DEVELOPED	PERCENTAGE OF FRUITS DEVELOPED [a]
I	12	87	12 87	12 73	100 83.90
II	12	84	12 84	12 78	100 98.20
III	11	89	11 89	11 81	100 92.85
IV	13	75	13 75	12 71	92.80 94.67
V	13	87	13 87	13 80	100 92.75

[a] Based on number of flowers pollinated.

COWLICKS IN HORSES [1]

ABELARDO F. BACLIG

WITH FOUR TEXT FIGURES

In the Philippines, the law requires that the number and location of cowlicks [2] in large animals be included in the certificates of ownership and of transfer. Certain types of cowlicks and their location influence the price of horses. Because of this importance of the cowlicks of horses, a study was made of them in Pila, Calauan, Bay, Los Baños, Calamba, and Cabuyao, Laguna Province, from November, 1945, to March, 1946.

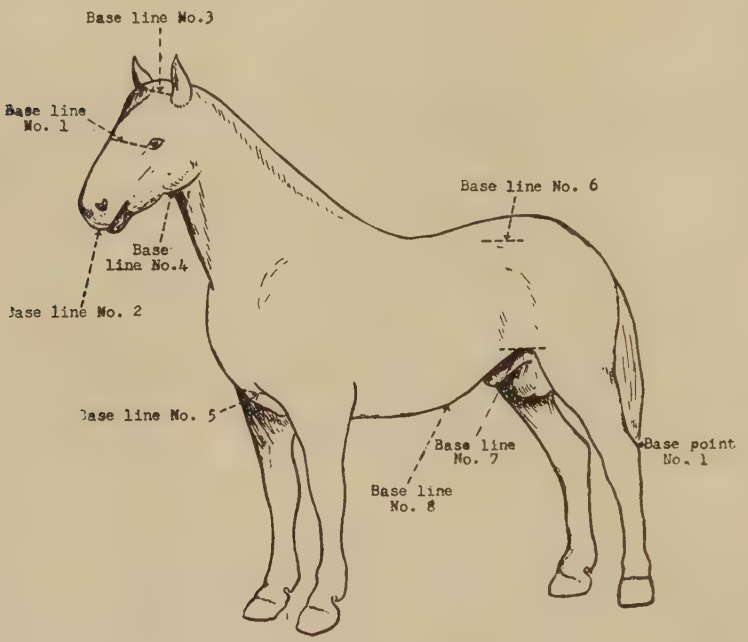

Fig. 1.—Base lines and base point by which locations of cowlicks were determined.

[1] Experiment Station Contribution No. 1616. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1946. Prepared in the Department of Animal Husbandry under the direction of Professor Valente Villegas.

[2] According to Webster's "Collegiate Dictionary of the English Language," 5th ed., G. & C. Meriam Company, Springfield, Mass., 1947, a cowlick is a "tuft of hair turned up or awry (usually over the forehead), as if licked by a cow."

MATERIALS AND METHODS

The study was made on 221 horses, 60.6 per cent of which were males and 39.4 per cent, females. The horses consisted of 90.1 per cent natives and 9.1 per cent grades. The average age was 6.86 years and the average height, 120.06 centimeters.

Base lines and a base point were established to indicate the location of the cowlicks (fig. 1). The base lines were: (1) a line from the medial canthus of the left eye to the medial canthus of the right eye; (2) the posterior border of the upper lip; (3) a line from the middle of the base of one ear to the middle of the base of the other; (4) a transverse line parallel with the throat latch; (5) a horizontal line across the floor of the chest; (6) a horizontal line drawn forward from the dorsal point of the hip (haunch); (7) a horizontal line tangent to the lower border of the rear flank; (8) the median

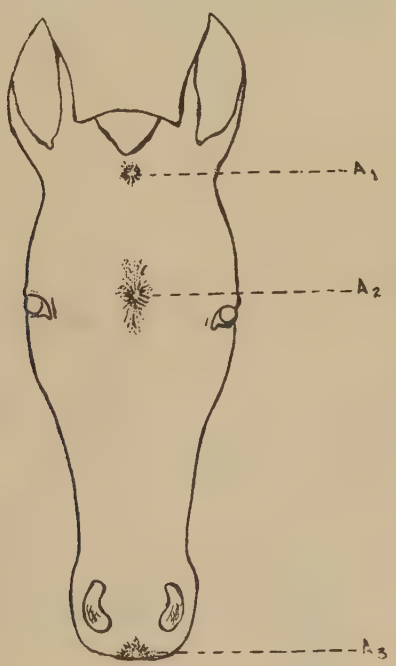

Fig. 2.—The general cowlick locations on the head (Group A).

line of the abdomen, from which the distance of the cowlick was measured laterally; and (9) a line across the abdomen, from the posterior part of the left rear flank to the posterior part of the right rear flank, from which the distance of the cowlick was measured anteriorly. The point of the hock was designated as base point No. 1.

The beliefs regarding the positions of cowlicks on the body of a horse were secured from interviews of horse owners and horsemen in the municipalities where the study was made.

RESULTS

Standard cowlicks

Cowlick A1. Of the 221 horses examined, 218 or 98.5 per cent had cowlicks on the forehead at the lower tip of the base of the forelock (fig. 2). The hairs of the cowlick were directed outward from the center in a ray-like manner. The cowlick was located between ten centimeters and nineteen centimeters above base line No. 1. The greatest frequency was fifteen centimeters above the base line, or a mean of 14.212 $\mp$ 0.088 centimeters and a standard deviation of 1.307.

Cowlick A2. All the horses observed had this type of cowlick, which was found on the face between the eyes (fig. 2). The hairs followed a ray-like pattern, radiating outward from the center. In

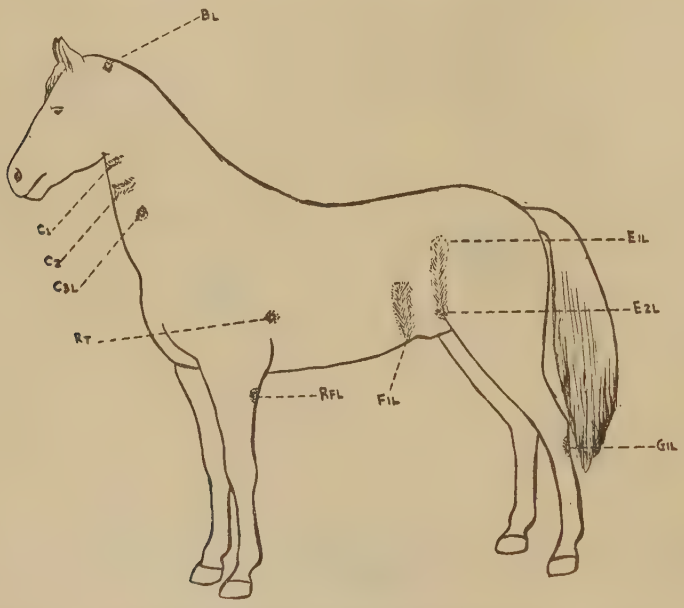

Fig. 3.—The locations of other typical and rare cowlicks.

some horses more than one cowlick of this type was found. Thirteen horses, or 5.9 per cent, had two of this type of cowlick, and two horses, or 0.9 per cent, had three. The cowlick was located between six centimeters below and sixteen centimeters above base line No. 1, or a mean of 3.417 $\mp$ 0.183 centimeters from the base line and a standard deviation of 2.711. The one on the base line or nearest to it was designated *A2a,* the next, *A2b,* and the farthest, *A2c. A2a*

and *A2* were taken as *A2*. Sixteen horses, or 7.3 per cent of the horses studied, had the cowlick on the base line; 187, or 84.6 per cent, above the base line; and 18 horses, or 8.1 per cent, below the base line. *A2b* was present in fifteen horses, or 6.8 per cent of all the horses studied. The location varied from three to eleven centimeters above base line No. 1, the mean being 5.6 centimeters above the base line. *A2c* was observed in two horses, or only 0.9 per cent of the horses studied, indicating that this type of cowlick is uncommon. One occurred at five, and the other at ten centimeters above base line No. 1.

Cowlick A3. This cowlick was found on the upper lip. It was usually inconspicuous and obscure, thus necessitating close scrutiny. The hairs were directed outward from the center in a ray-like manner and showed a slight tendency to rotate. Cowlicks which were 3.5 centimeters from base line No. 2 had the greatest frequency, the mean being 3.23 centimeters forward from the base line. All the 153 horses observed showed this type of cowlick.

Cowlick B. This cowlick was found at the dorsal part of the neck (fig. 3), between three centimeters anterior and twenty-five centimeters posterior to base line No. 3. The greatest frequency was four centimeters from the base line, the mean being 3.959 ∓ 0.217 centimeters and the standard deviation, 3.196. The hairs rotated outwardly from the vortex. Five horses, or 2.3 per cent, did not show this type of cowlick. One horse, or 0.4 per cent, had one cowlick on the left side and none on the right. Three horses, or 1.4 per cent, had two each on the left side, which were designated *BLa* and *BLb*, *BLa* being anterior to *BLb*. *BLa* and *BL* were taken as *BL* in this study. Cowlick *BLb* was observed in three horses, or 1.4 per cent of the horses. The range of location was from base line No. 3 to ten centimeters posterior to it.

BR on the right side was the homologue of *BL*. The location varied from four centimeters anterior to forty-five centimeters posterior to base line No. 3. The greatest frequency was four centimeters from the base line, the mean was 4.631 ∓ 0.365 centimeters, and the standard deviation, 5.380. Four horses, or 1.8 per cent, did not have this type of cowlick, but in some horses both *BRa* and *BRb* appeared simultaneously. *BRb* was observed in two horses, or 0.9 per cent of the horses studied. One was two centimeters, and the other six centimeters, posterior to base line No. 3, the mean being four centimeters.

Cowlick C1. This cowlick was found in the anterior region of the ventral part of the neck (fig. 3), more specifically, from the throat latch to about ten centimeters posterior to it. The hairs spread out in a fanlike manner in two opposite directions. Of the horses studied, only two, or 0.9 per cent, did not show this cowlick. The highest frequency of its occurrence was at three centimeters posterior to base line No. 4, the mean being 2.849 ∓ 0.106 centimeters and the standard deviation, 1.582.

Cowlick C2. This cowlick was well-defined on the ventral part of the neck. The hairs rotated inward toward the vortex. Two cowlicks, *C2a* and *C2b,* were sometimes present in the same animal, *C2a* being closer to the base line than *C2b.* In this study, *C2a* and *C2* were considered as *C2. C2* was observed in fifty-four horses, or 24.4 per cent of the total number of horses studied. The location ranged from five centimeters to thirty-six centimeters posterior to base line No. 4, the mean being 18.70 centimeters. The range of location of *C2b,* which was present in eight horses, or 3.6 per cent, was from nineteen centimeters to forty-five centimeters posterior to base line No. 4.

Cowlick C3. When found on the left side of the ventral surface of the neck, this cowlick was designated *C3L,* and *C3R* when found on the right side. This type was well-defined, and the hairs were directed outwardly and spirally from the center. *C3La* and *C3Lb* were both found in some horses, *C3La* being anterior to *C3Lb. C3La* and *C3L* were designated *C3L* in this study. Sixteen horses, or 7.2

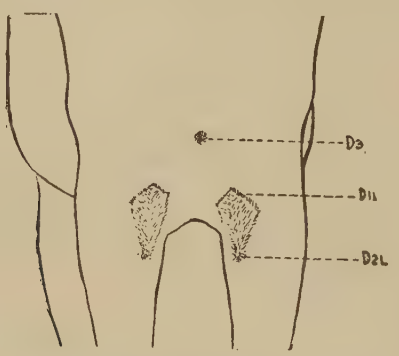

Fig. 4.—The general cowlick locations on the breast (Group D).

per cent of the horses studied, showed *C3L.* The location ranged from two centimeters to twenty-six centimeters posterior to base line No. 4, the mean being 7.8 centimeters. *C3Lb* appeared at ten centimeters posterior to base line No. 4 in one horse, or 0.4 per cent of all the horses.

Two cowlicks, *C3Ra* and *C3Rb,* appeared in the same animal, *C3Ra* being nearer to the base line than *C3Rb. C3Ra* was grouped with *C3R* in this study. Twelve horses, or 5.4 per cent of the total number of horses studied, showed *C3R.* The range of location was from three centimeters to twenty centimeters posterior to base line No. 4, the mean being 7.16 centimeters. Cowlick *C3Rb,* which occurred nine centimeters from base line No. 4, was found in two horses, or 0.9 per cent of the horses studied.

Cowlick D1. Two subtypes of this cowlick, *D1L* and *D1R*, were found on the breast above the floor of the chest (fig. 4), *D1L* being on the left side and *D1R* on the right side. The hairs from the neck and breast met the hair-streams of cowlicks *D2L* and *D2R* to form cowlicks *D1L* and *D1R*. The hairs spread out in a fan-like manner from the vortices of these cowlicks. *D1L* is subdivided into *D1La* and *D1Lb*, *D1La* being anterior to *D1Lb*. *D1La* and *D1L* are grouped together and taken as *D1L*. Two hundred horses, or 99.6 per cent, had the *D1L* cowlick. Its distance from base line No. 5 varied from two centimeters to twenty-five centimeters, the highest frequency being at ten centimeters. The mean was 10.327 $\mp$ 0.202 centimeters and the standard deviation, 3.011. *D1Lb*, which was found in three horses, or 1.4 per cent of the total number, was either on base line No. 5 or eighteen centimeters above it. The mean was 11.33 centimeters above the base line. Two cowlicks, *D1Ra* and *D1Rb*, were found simultaneously in some horses, *D1Ra* being anterior to *D1Rb*. *D1Ra* was grouped under *D1R*. The position of *D1R* varied from three centimeters to twenty-five centimeters above base line No. 5, the highest position being ten centimeters. The mean was 10.581 $\mp$ 0.221 centimeter and the standard deviation, 3.310. This cowlick was observed in two hundred, or 99.6 per cent of the horses. Only one horse, or 0.4 per cent, had *D1Rb*. The location was twenty-six centimeters above base line No. 5 (fig. 4).

Cowlick D2. This cowlick, present as *D2L* on the left side and *D2R* on the right side, was located from the upper medial and anterior surface of the forearm to the lower part of the breast (fig. 4). The hairs were arranged spirally around the center, spreading out distinctly like a fan at the top. *D2L* was observed in all the horses studied, its distance from base line No. 5 being from eight centimeters below to nine centimeters above it. The highest frequency was at three centimeters below the base line, while the mean, with a standard deviation of 1.86, was 3.217 $\mp$ 0.125 centimeters from the base line. *D2R* was also found in all the horses. The range of location was from eight centimeters below base line No. 5 to nine centimeters above it. The greatest frequency was 3 centimeters below the base line. The mean was 3.280 $\mp$ 0.131 centimeters from the base line, with a standard deviation of 1.95.

Cowlick D3. This cowlick was found in the region of the breast along the median line. The hairs spread out from the vortex in a spiral manner. Two cowlicks, *D3a* and *D3b*, both occurred in fourteen, or 6.3 per cent of the horses, *D3a* being anterior to *D3b*. The mean distance of cowlick *D3* was 13.14 centimeters above base line No. 5. *D3b*, located at 13 centimeters above base line No. 5, was observed in one horse, or 0.4 per cent of the horses studied.

Cowlick E1. Two cowlicks were observed in front of the points of the hip (haunch), *E1L* on the left side (fig. 3) and *E1R* on the right side. The hairs from the back and loins met the hair-streams of *E2* to form this type. The hairs spread out in a fan-like manner

from the center of the cowlick where hair-streams from opposite directions met. One horse showed two cowlicks, *E1La* and *E1Lb*, *E1La* being anterior to *E1Lb*. *E1La* was grouped with *E1L* in this study. All the horses studied had cowlick *E1L*. The range of location was from nine centimeters below base line No. 6 to five centimeters above it. The highest frequency was at two centimeters below the base line, the mean being 2.304 $\mp$ 0.165 centimeters from the base line and the standard deviation, 2.468.

E1R was present as *E1Ra* and *E1Rb*, *E1Ra* being anterior to *E1Rb*. *E1Ra* was considered under *E1R* in this study. All horses had this cowlick, which ranged from nine centimeters below base line No. 6 to five centimeters above it. The highest frequency was at two centimeters below the base line, the mean being 2.113 $\mp$ 0.167 centimeters from the base line and the standard deviation, 2.491. Only one horse, or 0.4 per cent of the horses, showed *E1Rb*, which was located five centimeters below base line No. 6. The same horse also had cowlick *E1Lb*.

Cowlick E2. Two subtypes of this cowlick, namely, *E2L* on the left side and *E2R* on the right side, appeared at the rear flank (fig. 3). These cowlicks were well-defined. The hairs spiralled outward from the vortex and spread out like an elongated fan at the top. Six horses, or 2.7 per cent, exhibited two subtypes of *E2L*, *E2La* being anterior to *E2Lb*. *E2La* was grouped with *E2L*. The range of location of *E2L* was from three centimeters below base line No. 7 to twenty centimeters above it. The highest frequency was at the base line. The mean was 4.212 $\mp$ 0.284 centimeters from the base line and the standard deviation, 4.232. *E2Lb* occurred in six horses, or 2.7 per cent of the horses studied. The mean was 10.5 centimeters above the base line.

E2R also occurred as two subtypes, *E2Ra* and *E2Rb*, *E2Ra* being anterior to the other. *E2Ra* and *E2R* were grouped together as *E2R*. The location of *E2R* was from three centimeters below base line No. 7 to eighteen centimeters above it. The mean was 4.651 $\mp$ 0.258 centimeters above the base line, and the standard deviation was 3.847. *E2Rb* was found in ten horses, or 4.5 per cent of the horses studied, at a mean distance of 10.5 centimeters above base line No. 7.

Cowlick F1L. This well-defined cowlick was found in the region of the abdomen (fig. 3). The hairs of the abdomen spiralled inward towards a vortex to form this cowlick. Two subtypes, *F1La* and *F1Lb*, were sometimes present in the same animal, *F1La* being anterior to the other. *F1La* and *F1L* were grouped together as *F1L*. The location of cowlick *F1L* laterally from base line No. 8 ranged from one centimeter to sixteen centimeters. The mean was 7.434 $\mp$ 0.145 centimeters and the standard deviation, 2.159. Anteriorly, the same cowlick was located from one centimeter to eighteen centimeters from base line No. 9. The mean was 11.294 $\mp$ 0.170 centimeters and the standard deviation 2.534. *F1Lb* was found in one horse,

which represented 0.4 per cent of the horses studied. It appeared nineteen centimeters laterally from base line No. 9 and ten centimeters anteriorly from base line No. 8.

F1R appeared as subtypes *F1Ra* and *F1Rb,* the former being anterior to the latter. *F1Ra* was included with *F1R* in this study. Laterally, the distance of *F1R* from base line No. 9 ranged from one centimeter to sixteen centimeters, the mean being 7.063 $\mp$ 0.169 centimeters, and the standard deviation, 2.508. Anteriorly, the same cowlick was one centimeter to eighteen centimeters from base line No. 8, the mean being 11.185 $\mp$ 0.170 centimeters and the standard deviation, 2.531. *F1Rb* was found in only one horse, or 0.4 per cent of the horses studied. Its location was eighteen centimeters laterally from base line No. 9 and eleven centimeters anteriorly from base line No. 8. The same horse had *F1Lb.*

Cowlick F2. This cowlick was located at the median line of the abdomen, eight centimeters anterior to base line No. 9. It was observed in only one horse, or 0.4 per cent of the horses studied.

Cowlick G1. This cowlick, which was small and inconspicuous, was found at the rear of the cannon of the hind limb. The hairs were arranged spirally around the vortex. Two subtypes, *G1L* on the left leg and *G1R* on the right leg, were observed. *G1L* was further subdivided into *G1La* and *G1Lb, G1La* being above *G1Lb. G1La* was grouped with *G1L.* Fifteen horses, or 6.8 per cent of the horses studied had *G1L,* the mean location of which was 15.66 centimeters below base point No. 7. *G1Lb* occurred in only one horse, or 0.4 per cent of the horses studied, at nineteen centimeters below base point No. 1.

G1R had subtypes *G1Ra* and *G1Rb,* the former being anterior to the latter. *G1Ra* and *G1R* were grouped as *G1R.* Thirteen horses, or 5.9 per cent of the horses studied had *G1R.* The mean location was 15.76 centimeters below base point No. 1. *G1Rb* occurred in only one horse, or 0.4 per cent of the horses studied. It was located nineteen centimeters below base point No. 1 in the same horse that showed its counterpart, *G1Lb.*

Rare cowlicks

Of the total number of horses observed, 8.6 per cent showed 18 rare cowlicks at locations other than those occupied by standard cowlicks. All these rare cowlicks were well-defined. The hairs spiralled around a center or vortex. The cowlicks were designated R and grouped according to the location on the body. For example, a rare cowlick found on the head was designated R_H.

Of the horses with rare cowlicks, seven horses, or 38.9 per cent, had the cowlicks on the head on the lower border and lateral surface of the mandibles and above the corner of the mouth. One horse, or 6.1 per cent, had a rare cowlick in the region of the shoulder. It

occurred fourteen centimeters on the left side and sixteen centimeters on the right side above the underline. One horse, or 6.1 per cent, had a cowlick in the region of the chest, fifteen centimeters above the elbow and in line with the heart girth. Eight horses, or 44.5 per cent, had rare cowlicks on the posterior and lateral surfaces of the fore limb. One horse, or 6.1 per cent, had a rare cowlick on the posterior edge of the left thigh, thirty-two centimeters above the hock.

Beliefs associated with cowlicks

Local horse raisers associate the cowlicks of horses with superstitious beliefs about performance and behavior. For this reason, the price of a horse is influenced by the location and arrangement of its cowlicks. If the cowlick is located above base line No. 1, the horse is believed to possess a good disposition; if below, or *sulyáp* (glance), the horse is claimed to be excitable and shy. Of the horses studied, 7.2 per cent had the *sulyáp* cowlick. Paired cowlicks directly opposite each other on the neck are said to be *naturál* (ordinary). If the cowlicks are located on a straight line between the ears, they are referred to as *bagtíng* (string), and the horse is believed to possess endurance. If one of the pair is near one ear and the other far to the rear of the other ear, cowlicks are called *espada y daga* (sword and dagger), and the horse possessing these cowlicks is feared for the calamity it is supposed to bring to the rider. Five horses, or 2.6 per cent, showed this particular pattern of cowlicks. Paired cowlicks located under the cheek band of the headstall are called *dagán* (pressed). The horse with these cowlicks is said to be liable to accidents. This arrangement of cowlicks was found in 69.4 per cent of the horses.

An animal with the cowlick known locally as *ulohipan* (centipede), which is located under the collar when the horse is in harness, is believed to be weak and to lack the courage to climb steep grades. The cowlick on the front of the chest, but not the *ulohipan* (centipede), is called the *bangga* (collision) cowlick. The horse with this cowlick is said to be liable to collisions. The cowlick located on the side of the chest behind the elbow is called *kidlat* (lightning), and its presence is said to make the horse liable to being struck by lightning.

A horse with joined cowlicks, known locally as the *plumahe* (duster), is said to be deficient in stamina when one of the pair is about midway between the rear flank and the point of the hip. When the other is located above the point of the hip, or is exposed to the sun (*bilad*), the animal is believed to possess endurance, especially against the sun. When two cowlicks are separated or disjoined, the horse is expected to bring misfortune in business.

Cowlicks on the cannon, either on the foreleg or hind leg, are desirable; the horses with these cowlicks are supposed to possess endurance.

SUMMARY

1. Two hundred and twenty-one horses, of which 60.6 per cent were males and 39.5 per cent, females, were examined for cowlicks. The horses consisted of 90.1 per cent natives and 9.9 per cent grades.

2. There were 23 standard cowlicks, three of which were on the head, two on the dorsal part of the neck, four on the ventral part of the neck, five on the breast, four in the region of the rear flank and in front of the haunch, three on the abdomen, and two at the rear of the cannon of the hind leg. Seven cowlicks were unpaired and medially located; 16 appeared in pairs, eight on the left side and eight on the right side.

3. Eighteen horses, or 8.6 per cent of all the horses, had rare cowlicks. Seven, or 38.9 per cent, had them on the head; one, or 6.1 per cent, on the shoulder; one, or 6.1 per cent, on the thorax; eight, or 44.5 per cent, on the fore limb; and one, or 6.1 per cent, on the hind limb. The hairs in the rare cowlicks spiralled outward from a vortex.

4. Age, color, breeding, height, and sex identified one animal from another whenever two animals had identical patterns of cowlicks.

5. Certain beliefs are associated with cowlicks *A2*, *B1L* and *B1R*, *C2*, *E1L and E1R*, and *E2L* and *E2R* but none with the rare cowlicks.

A GENETIC STUDY OF VARIEGATION IN RICE [1]

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Of the Department of Agricultural Botany

A yellow-striped mutation of rice whose tillers showed green and variegated sections had been under culture for one year at the College of Agriculture, Los Baños, before the present study was begun. To determine the type of heredity shown by the mutant variegation, this study was conducted in the Department of Agricultural Botany from December, 1948, to March, 1950.

MATERIALS AND METHODS

Grains from an original, yellow-striped mutant rice plant, variety Macarato, were used. The variety is upland, which matures in about 131 days and is normally awnless. The leaves, stems, and spikes are characterized by yellow striping, the demarcation between the yellow and green stripes on the leaves being very sharp. Except for a few brown specks, the lemmas and paleas are pure yellow.

The grains were soaked in water for twenty-four hours and then sown in a seedbed. The seedlings were transplanted to the culture pots, which were empty gasoline drums half a meter in diameter and cut transversely in halves. Signs of chlorophyll deficiency were observed in the growing plants. Four chlorophyll-deficient seedlings were produced, but these died about one-half month after germination. F_1 seeds, or mature selfed seeds harvested from the normal green plants, were planted in the same way as the parent seeds. Similar care was given to the plants, but they turned chlorotic and soon died. F_2 seeds, harvested from the normal green plants, since the yellowish-white seedlings died early without reaching the reproductive stage, were planted the next planting season. From the ratoons of the F_2 plants, a number of albino tillers appeared which died two weeks after emergence. F_2 seeds were again sown, the seedlings transplanted, and the plants taken care of in the same way as the first and second plantings. The mutants and normal green plants were observed and counted. From the three generations of selfed progeny populations, not a single variegated plant was recovered. Microscopic examination of the green and yellowish-white sections of the leaf blades was made to determine the distribution of chloroplasts in the different cell layers.

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[1] Experiment Station Contribution No. 1617. Based on the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, April, 1950.

DISCUSSION OF RESULTS

The progenies of the variegated plants segregated into yellowish-white and normal green seedlings in the three successive generations. The former lived only from ten to twenty days, or as long as the food in the seeds lasted. In some cases, a faint tinge of yellow appeared on the leaves, but this was thought to be caused by the gradual aging of the tissue. Of this chlorophyll aberrant, two categories could be distinguished, namely, (1) those which were yellowish-white in every part of the plant body from the earliest period of growth after germination and (2) those which showed, in their early period of growth, a pale green color in the upper part of the sheath of the first leaf and a pale yellow or white in the other parts but later became entirely yellowish-white. Both these types of plants, which may be regarded as albinos, died before they reached the height of about 10 centimeters. The results seem to indicate that the albino seedlings of rice, as of other plants, continue to live only as long as the food material in the endosperm lasts, inasmuch as they are devoid of chlorophyll and cannot produce their own organic food.

One plant in the present study was observed to have produced an albino tiller which was pure white in every part of the plant body. The tiller died four days after emergence. The leaves turned yellowish-white, showing that albinism is produced in ratoons. As expected, they dried up a week after emergence.

Microscopic examination of the leaf blades showed that some layers of mesophyll cells of the yellowish-white plants were completely devoid of chlorophyll, while the layers of mesophyll cells in the normal green plants contained normal chloroplasts. Evidently, the yellowish-white or white color of some plants is due to chlorophyll deficiency.

Hereditary basis of chlorophyll-deficient plants among selfed progenies of the variegated mutant plant

Counts of the normal green and the yellowish-white individuals in the first, second, and third generations of progenies were made, and the data obtained were tested for agreement between observed and expected class frequencies on the basis of monogenic (3 : 1), digenic (15 : 1), and trigenic (63 : 1) segregations (table 1). The test of closeness of fit was resorted to on the suspicion that chlorophyll deficiency is an inherited character and that one or more pairs of genes might be involved in its heredity. The statistical procedure adopted was the chi-square test.

The chi-square tests (table 1) indicate that the yellowish-white seedlings among the selfed progenies of the variegated mutant rice plant were governed by more than one pair of genes. On the 3:1 hypothesis, a probability of less than 0.01 was obtained, showing

that the deviation from monogenic segregation was highly significant and hence a poor fit. This suggests that chlorophyll deficiency was not governed by one pair of genes. Calculated on the basis of the 15 : 1 hypothesis wherein two pairs of genes or duplicate factors are involved, a probability of 0.08 was obtained, indicating a slightly fair agreement on digenic inheritance. The closeness of fit, however, was not what might be considered stable. The figure obtained on the basis of the 63 : 1 hypothesis gave the closest and best fit as to the Mendelian nature of heredity of the chlorophyll-deficient plants. The chi-square, on this trigenic segregation, gave a probability of 0.83, showing definitely that three pairs of genes were involved.

The interpretation of the results obtained in the present investigation seems to agree in part with those of previous works on chlorophyll-deficient forms in rice. In the first place, the original mutant variegated plant used in this study split into normal green and yellowish-white or albino plants in the subsequent and consecutive selfed progenies for three generations. Segregation of variegated plants into various forms of chlorophyll-deficient individuals have been reported elsewhere.

De la Houssaye [2] believes that rice, being a self-fertilized crop, may not produce as many mutants as cross-fertilized crops when selfed. Moreover, he noted that the chlorophyll-deficient mutants which occur in rice, especially among selfed generations, are generally of the types which mutate to recessive forms. According to him, these chlorophyll-deficient forms are not carried in the heterozygous state, and he seems to suggest that the rate of mutation of the chlorophyll-deficient character is fairly high in rice.

De la Houssaye enumerates the contributions of other workers in his paper. According to him, Morinaga noted that yellow or albino seedlings are controlled by duplicate factors. Ramiah reported that the appearance of albinos is due to recessive genes, but a yellow type of rice which he isolated gave both monogenic (3 : 1) and digenic (15:1) ratios of normal green to yellow seedlings. Morinaga recorded white seedlings which behaved as simple recessive to green, giving a 3 : 1 ratio. Kadam and Patankar recorded ratios of 3 : 1 and 15 : 1 of green to yellow in certain rice families. Codd reported segregation involving three factors in the appearance of albinos from green individuals. Ramiah and Ramamijam recorded the segregation of albinos, yellows, and greens up to three generations and found segregating ratios of 3 : 1 in one generation and 9 : 3 : 4 in another generation. In the majority of the cultures, however, they found that three pairs of factors were concerned in the development of the chlorophyll, which behaved as an ordinary Mendelian unit character. Ramiah and Ramamijam further isolated three kinds of variegated plants and studied their color inheritance

[2] De la Houssaye, D. A. 1943. A chlorophyll deficiency in rice. Proc. Louisiana Acad. Sci. 7: 27–34.

from selfed progenies. They found that the chlorophyll-deficient character was inherited through the mother, the male parent having no effect on the transmission of this character. This observation, together with the irregular segregation ratios they obtained in selfed progenies and the random distribution of the different kinds of seedlings and the different tillers of the same plant, suggested to them that the plastid, rather than the nucleus, is concerned in the variegation of rice.

The foregoing reports of other workers point to the interaction of two pairs of factors (15 : 1) as the possible agreement for Mendelian heredity. The present workers, however, believe that the operation of three pairs of factors (63 : 1) is the best fit possible. The data obtained from the selfed progeny population studied seem to suggest that the chlorophyll deficiency extracted from variegated plants through selfing segregated into digenic ratios of 15 : 1 and trigenic ratios of 63:1. It should also be noted that the original variegated plant character did not appear again even after three generations of cultures. Since the albinos did not reach the reproductive stage, it might be deduced that they were governed by three recessive genes which proved lethal in the homozygous state.

Hunter and Leake [3] reported the observation of Ramiah that pure white seedlings which appeared as a common feature of rice cultures in Coimbatore, India, died as soon as the reserve material of the grains was exhausted. The character could only be studied in the heterozygous form which phenotypically appeared as green. The segregation obtained indicated that the normal green seedlings were dominant over the yellowish-white, and ratios of 3:1 and 15:1, as well as others more complicated, were derived. These results suggest that several genes were concerned in the development of the chlorophyll-deficient plant. A similar type of heredity and variability of the chlorophyll deficiency was observed in the present study. The variegated plant invariably produced green and yellowish-white progenies, the heterozygous form being normal green.

Another interesting feature in the variegated rice plant noted by the writers was that white variegation was recovered, or reproduced true to its clonal progeny, the tillers and subsequent ratoon crop. This character was no longer manifested in the sexual or seminal progeny arising from self-fertilization. The segregating types were always normal green and yellowish-white or albino seedlings, which presumably were maintained in the heterozygous state. This heterozygote was normally green.

The condition of variegation observed in this study gives rise to two possible conclusions: (a) when the plant is asexually propa-

[3] HUNTER, H., AND H. M. LEAKE. 1933. Recent advances in agricultural plant breeding. viii + 361 p., 16 pl. Philadelphia: P. Blakiston Sons and Company, Inc.

gated or clonally reproduced, variegation is retained, suggesting cytoplasmic or plastid inheritance; (b) when the plant is sexually propagated through selfing for three generations, the inheritance is nuclear and Mendelian in nature and closely agrees with trigenic segregation, wherein three pairs of genes are in operation.

SUMMARY AND CONCLUSION

1. The selfed progenies of the variegated rice plant, variety Macarato, segregated into normal green and yellowish-white seedlings in the ratio of 63 : 1, suggesting that three pairs of genes are concerned in this chlorophyll variant.

2. No variegated plant appeared in the selfed progeny, although its subsequent progeny produced two phenotypes, green and yellowish-white.

3. Variegation is maintained in the tillers and ratoon crops when the variegated plant is reproduced asexually.

4. The chlorophyll variation is a nuclear or Mendelian characteristic in seed progeny but is probably cytoplasmic or plastid in asexual offspring.

TABLE 1

Number of green and yellowish-white plants in three generations of progenies of self-fertilized, heterozygous green plants; numbers expected under monogenic (3 : 1), digenic (15 : 1), trigenic (63 : 1) inheritance; and values of chi-square

PROGENY	TOTAL NO. OF PLANTS	OBSERVED		
		Green	Yellowish-white	
F_1	90	87	3	
F_2	160	154	6	
F_3	109	107	2	
Total	359	348	11	
		EXPECTED (3 : 1)		
		Green	Yellowish-white	X^2
F_1	90	67.5	22.5	22.5333
F_2	160	120.0	40.0	38.5333
F_3	109	81.75	27.25	31.1956
Total	359	269.25	89.75	92.2622 P = .01
		EXPECTED (15 : 1)		
		Green	Yellowish-white	X^2
F_1	90	84.37	5.63	1.3104
F_2	160	150.00	10.00	1.7066
F_3	109	102.20	6.80	3.6136
Total	359	336.57	22.43	6.6306 P = 0.08
		EXPECTED (63 : 1)		
		Green	Yellowish-white	X^2
F_1	90	87.60	2.40	.1541
F_2	160	151.71	8.29	.6670
F_3	109	107.30	1.70	.9537
Total	359	346.61	12.39	.8748 P = 0.83

THE EFFECT OF WORLD WAR II ON THE QUALITY OF THE HORSES IN BAY, CALAUAN, AND PILA, LAGUNA [1]

MANUEL G. BANZON, JR.

Durham (1911) described the Philippine horse as generally swift, strong, elegant, with well-formed shoulders and an admirable power of endurance when properly cared for. Its weak points are an almost universal lack of gaskin measurement and poorly formed forelegs.

In Bay, Calauan, and Pila, Laguna, where the 1939 census of the Philippines reported 24, 193, and 112 horses, respectively, a study was made to determine the effect of the war on the quality of the horses. The study was considered essential because during the occupation, especially in 1944, the horses were confiscated by the Japanese Army for use as beasts of burden. Many of them were never seen by the owners again. The study was made from August, 1945, to September, 1946, to determine (*a*) the age, sex, color, blood composition, height, and condition of the horses found in the municipalities of Bay, Calauan, and Pila; (*b*) the defects in conformation and the unsoundnesses of the animals; (*c*) the proportion of breeding stock to work animals; and (*d*) the selling prices of the horses sold in 1945 and 1946.

Method of study

A total of 220 horses, of which 54 were in Bay, 82 in Calauan, and 84 in Pila, was studied.

As conditions permitted, weekly trips to Bay, Calauan, and Pila and their barrios were made. In these visits, the names of the owners were taken to identify the animals and prevent duplication of work. The condition of the animals and their defects and unsoundnesses were determined by careful examination. The height was determined by letting the horse stand squarely on its four feet on level ground and measuring the vertical distance from the ground to the withers. The color names of the horses were decided in consultation with the owners and horsemen. To determine the blood composition, the general appearance of the horse was studied and the writer's conclusion was corroborated by the owner. The age of the horses was determined by their dentition—among animals under five years by the eruption of the temporary and permanent incisors and among horses over five years by the wear of the incisors—and checked with the certificate of ownership and of transfer.

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[1] Experiment Station Contribution No. 1618. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, November, 1946. Prepared in the Department of Animal Husbandry under the direction of Professor Valente Villegas.

RESULTS

Of the 220 horses studied, 132, or 60 per cent, were males and 88, or 40 per cent, were females; the sex ratio was 60 per cent. In Bay, the sex ratio was 57.4 per cent; in Calauan, 64.6 per cent; and in Pila, 57.1 per cent. Because horsemen generally do not want their stallions unsexed, only two of the horses were found to be castrated. Horsemen believe that castration lowers the stamina and spirit of an animal. Nine, or 6.8 per cent of the males, were cryptorchids.

As regards blood composition, 201, or 91.40 per cent of the horses were native and 19, or 8.64 per cent, were grades. Nine, or 47.37 per cent of the grades were in Bay; 6, or 31.58 per cent, in Calauan; and 4, or 21.05 per cent, in Pila.

The horses varied in height from 110 centimeters (43.3 inches) to 136 centimeters (53.5 inches). The majority were 121 centimeters (47.7 inches) high; the mean height was 121 $\mp$ 0.331 centimeters (47.7 inches), and the standard deviation was 4.937. Lizaso (1921) found that the average height of horses in Bay, Los Baños, and Calamba, Laguna, was 123.7 centimeters (48.7 inches). Reduque reported the average height of horses in Los Baños, Calamba, and Cabuyao, Laguna, as 122.6 $\mp$ 0.431 centimeters (47.6 inches). The mean height reported by Lizaso is greater than that obtained in this study but about equal to the finding of Reduque.

Lizaso (1921) reported the average age of the horses he studied as 6.9 years; Reduque, 6.8 years. The horses studied by the writer were from 2 to 15 years. Most of them were 7 years old; many were 8, 9, or 6 years old. The mean age was 7.3 $\mp$ 0.1657 years, and the standard deviation, 2.456.

In a study of 8,000 horses, Ellenberger (1921) found that 2 to 3 per cent of all the mares had canines in both jaws; 6 to 7 per cent, only in the upper jaw; and 20 to 30 per cent, in the lower jaw. Of the 88 female horses studied by the writer, 7, or 7.95 per cent, had canines in the lower jaw and 3, or 3.41 per cent, in the upper jaw. No mare was found to have canines in both jaws.

Lizaso (1921) and Reduque (1946) reported bay as the most common color in horses. The writer also noted that bay was the color of 71, or 32.27 per cent, of the horses. Gray in various shades was the color of 37, or 16.82 per cent: white on a dark skin in 34 horses, or 15.45 per cent; iron gray in 2 horses, or 0.91 per cent; flea-beaten gray in 2 horses, or 0.91 per cent; and dapple-gray on 1 horse, or 0.45 per cent. Buckskin occurred in 33 horses, or 15.00 per cent; roan in 22 horses, or 10.00 per cent. Eighteen horses, or 8.18 per cent, were red roan, and 4, or 1.81 per cent, were blue roan. Black was the color of 17 horses, or 7.72 per cent: light or sooty black in 12 horses, or 5.45 per cent, and jet black in 5 horses, or 2.27 per cent. Eleven horses, or 5.00 per cent, were chesnut in color.

Nine horses, or 4.09 per cent, were cream and 7 horses, or 3.19 per cent, were brown. Palomino, also known as Isabella, was observed in 7 horses, or 3.19 per cent. Mouse color was found in 3 horses, or 1.36 per cent; skewbald in 2 horses, or 0.91 per cent; and cremello or albino in 1 horse, or 0.45 per cent. White markings were mostly present in bay-colored horses, although some of the black, buckskin, and brown ones also had white markings.

The writer noted that 122 horses, or 55.5 per cent, were of medium flesh; 46, or 20.9 per cent, were thin; and 52, or 23.6 per cent, were fat. Reduque (1950) reported that most of the medium-fleshed and fat horses were found in Calamba, while the thin animals were mostly in Los Baños.

The writer found that 200, or 90.91 per cent of the horses were for pulling carromatas; 5, or 2.27 per cent, were brood mares; 3, or 1.37 per cent, were for riding; 1, or 0.45 per cent, was being groomed for racing; and 11, or 5.00 per cent, were pack animals.

Although the horses were generally small, they were observed to possess remarkable strength and endurance. In spite of their poor feed and care, the animals had sound bones and their legs were free from bony outgrowths or exostoses. They were willing workers in spite of abuse and overwork.

Concerning defects in conformation and unsoundnesses, the writer found dish-face in 32 horses, or 6.92 per cent; Roman nose in 15, or 3.24 per cent; eye sore in 6, or 1.29 per cent; and blindness in 1, or 0.22 per cent. According to the owner, the blindness was periodic or recurrent; hence, the writer believes the case to be one of moon blindness.

Collar sore, caused by ill-fitting collars, was the most common blemish on the neck and was found in 19 horses, or 4.11 per cent.

As to the defects of the forequarters, splayfoot was noted in 48 horses, or 10.38 per cent; interfering in 25, or 5.41 per cent; and flatfoot in 13, or 2.81 per cent. Pigeon-toe was found in 17 horses, or 3.68 per cent; knee-sprung in 9, or 1.94 per cent; broken knee in 6, or 1.29 per cent; and clubfoot in 11, or 2.28 per cent. Straight pasterns were exhibited by 3 horses, or 0.65 per cent, and calf-knee, by 3, or 0.65 per cent. Two horses dragged at the forelegs and one horse had capped knees. Scars were found on the foreflanks of 146 horses, or 66.36 per cent; fresh wounds were also observed.

As a rule the horses had fairly good bodies; the backs were short and strong. However, 8 horses, or 1.63 per cent, were pot-bellied; 5, or 1.08 per cent, slab-sided; and 5, or 1.08 per cent, sway-backed. Scars and fresh wounds due to poor-fitting saddles were found on the backs of 14 horses, or 3.03 per cent. Five horses, or 1.08 per cent, were suffering from epizootic lymphangitis, an infectious disease that is similar to farcy.

The writer noted that the hindquarters were generally deficient in muscling. Cow-hock, the most common defect, occurred in 67 horses, or 14.50 per cent. The majority of the horses had short croups. Drooping croup characterized 41 horses, or 8.87 per cent. Dragging of the hind feet occurred in 36 horses, or 7.89 per cent; interfering in 25, or 6.06 per cent. Twenty-four, or 5.18 per cent, were saberlegged or sickle-hocked. There were 21 horses, or 4.54 per cent, that forged and 2, or 0.43 per cent, that had wind puffs. Scars and fresh wounds from beatings by the drivers were noted in 12 carretela horses.

In his observation of the horses in Bay, Los Baños, and Calamba, Lizaso noted that the most common defects were small size, cow-hock, knock-knee, pigeon-toe, large head, overshot mouth, and poor muscling of the hind quarters. The good points observed were excellent quality of the skin and chest, wonderful stamina and recuperative power, and the ability to stand hard work even though poorly fed.

The brands required by law for identification purposes were blurred in 32 per cent of the horses. Most of the brands were complex. The simple and legible ones were V, M, C, PS, R, L, and ∫ᵛ∿.

The prices of horses sold during the period of the study were from ₱200 to ₱800, depending upon the quality of the animals. One grade stallion that used to be a race horse was sold for ₱1,200. All of the horses that were sold were used for pulling carromatas.

From personal observation and interviews with the owners, the writer found that the majority of the horses were not properly fed and managed, thus accounting for their poor condition. The horses were usually given barit (*Leersia hexandra*) and rice bran or corn; they were not given enough concentrate to keep them in good physical condition. The horses were kept in makeshift stables, tethered, or let loose on the farm when not harnessed to the carretelas.

The training of the horses started when they were one year old. The animals were first made to pull a sled with a light load. At the age of two years, they were trained in the harness and made to pull light carromatas. Since the owners constantly handled the young horses, the colts and fillies generally had good dispositions, and even among cryptorchids, vicious horses were seldom found.

SUMMARY

1. Of the 220 horses studied, 132 were males and 88, females; the sex ratio was 60 per cent. The animals consisted of 91.36 per cent natives and 8.64 per cent grades. The most common colors were bay, gray, buckskin, roan, black, and chestnut in the order named. There were 9 cryptorchids.

2. The height of the horses ranged from 110 centimeters (43.3 inches) to 136 centimeters (53.5 inches); most of them were 121 centimeters (47.7 inches) high. The mean age was 7.3 $\mp$ 0.16 years; the majority of the horses were 7 years old. Of the mares, 11.36 per cent had canines; 7.95 per cent had them in the lower jaw, and 3.41 per cent, in the upper jaw. No mare had canines in both jaws.

3. Twenty and nine-tenths per cent (20.9%) of the horses were thin, 55.5 per cent were of medium flesh, and 23.6 per cent were fat.

4. Ninety and ninety-one hundredths per cent (90.91%) were used for pulling carromatas; 2.27 per cent were brood mares; 1.37 per cent, riding horses; 0.45 per cent, race horse; and 5.0 per cent, pack horses. Although the horses used for pulling carromatas were poorly fed and cared for and overworked, they had remarkable strength and endurance. Their legs were clean and free from bony outgrowths or prominences; their bones were sound.

5. The price of carromata horses ranged from ₱200 to ₱800, and that of race horses, from ₱800 to ₱1,200.

6. Fourteen and five-tenths per cent (14.5%) of the horses were cow-hocked, and 10.38 per cent, splayfooted. The other common defects were drooping croup, dragging at the hind legs, dished face, interfering at the fore and hind legs, saber-leg or sickle-hock, collar sore, pigeon-toe, and Roman nose.

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EFFECTS UPON THE GROWTH AND YIELD OF UPLAND RICE PLANTS OF ADDING ANIMAL MANURE TO FERTILIZED AND UNFERTILIZED SOILS [1]

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WITH TWO TEXT FIGURES

To determine the extent of the benefits rice plants may derive from fertilized or unfertilized soil media treated with horse manure, experiments were conducted in the Department of Agricultural Botany from July, 1948, to October, 1949.

Cooper and Watts (1940) found from two trials that the addition of manure to soils treated with commercial fertilizers brought about increases of 1,576.65 and 1,702.77 melons to the acre, respectively. According to these authors, the greater amount of water available in the manured soils appeared to be a decided advantage for the plants.

Harris and Bracken (1917) reported that King, in 1892, found that manure influenced considerably the water content of the soil, which influence prevailed a year after manuring. These authors reported that Snyder, in 1893, found that manuring increased the moisture of soils during a period of drought. Harris and Jones (1917) concluded that manure, especially when as much as 20 tons to the acre (49.4 tons a hectare) were added, increased the water-holding capacity of cropped soils.

Parker and Jenny (1945) stated that water infiltration was directly related to the quantity of organic matter applied. Harris and Bracken (1917) reported that Whitney pointed out in 1889 that the urine present in manure tends to defloculate the soil particles and to prevent the moisture from being lost by downward movement.

MATERIALS AND METHODS

Iron drums 54 centimeters in diameter were cut transversely into halves. The bottoms were removed and the halves buried in the ground about forty centimeters apart. About 103 kilograms of thoroughly mixed and sifted Lipa clay loam soil was placed in each

[1] Experiment Station Contribution No. 1619. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, October, 1949. Prepared in the Department of Agricultural Botany under the direction of the late Professor Rafael B. Espino.

[2] The experiment was supposed to be of a factorial design, i.e., three factors at two levels each. However, only six treatment combinations were used instead of eight. Therefore, the data were analyzed as an ordinary complete randomized design and not as a factorial design. This is the main limiting aspect of the experiment.

of the pots, which were labeled cultures I, II, III, IV, V, and VI, respectively. Based on the analysis of a similar soil by Madrigal in 1941, the N content of cultures III, IV, V, and VI and the P_2O_5 content of cultures V and VI were raised to more or less 4 Baule units.[3] Ammonium sulfate, which contained 20.6 per cent N, and superphosphate, which contained an average of 19 per cent P_2O_5, were used. Fresh horse manure was gathered from the stable in the Department of Animal Husbandry and placed in the shade to dry. Cultures II, IV, and VI of sets I and II received horse manure at the rate of 48.0 tons a hectare, while the same cultures of set III received manure at the rate of 87.3 tons a hectare.

The amounts of commercial fertilizers and horse manure applied to each pot and thoroughly mixed with the soil were as follows:

CULTURE NO.	AMMONIUM SULFATE		SUPERPHOSPHATE		HORSE MANURE	
	Amount	N	Amount	P_2O_5	Set I or II	Set III
	grams	*grams*	*grams*	*grams*	*kg.*	*kg.*
I	—	—	—	—	—	—
II	—	—	—	—	1.1	2.0
III	102	21	—	—	—	—
IV	102	21	—	—	1.1	2.0
V	102	21	13.6	2.6	—	—
VI	102	21	13.6	2.6	1.1	2.0

Seeds of upland rice, variety Inintiw, were sown in each pot. When the plants were about five centimeters tall, they were thinned down to five plants of more or less the same height and vigor.

Three culture sets were tried, each set consisting of six culture types in four replications. Set I was planted on July 17, 1948, and harvested on November 16, 1948. The number of tillers, height of tops and length of roots, emergence of panicles, air-dry weight of tops and roots, and air-dry weight of filled and empty grains were observed. The data on these criteria are summarized in table 1.

Set II was started on November 17, 1948, and ended on February 23, 1949, because of the early death of the plants due to lack of moisture in the culture media. The weekly average moisture contents of the culture media are shown in table 2, and the average weekly growth increment of the plants may be seen in table 3.

On June 18, 1949, the third set was planted and was harvested on October 13, 1949. The fresh weight of tops and the number of bearing and nonbearing culms were recorded. The loss on ignition was determined at the end of the experiment through the courtesy

[3] By one Baule unit is meant the quantity of a fertilizing ingredient capable of producing 50 per cent of the maximum yield of any crop, provided all of the other conditions and growth factors are at their best, or are amply supplied. According to Willcox (1930), 4 Baule units are capable of giving 93.75 per cent of the maximum yield.

of the Department of Agricultural Chemistry. The data obtained for set III may be seen in table 4.

The average moisture contents of the culture media for each of the three trials and the loss on ignition in set III were based on the oven-dry weight of the samples.

The cultures were not watered artificially, but cultivation was done whenever necessary to kill the weeds and to conserve whatever moisture was obtained underground.

Weekly data on rainfall, relative humidity, air temperature, and wind velocity were taken from the weather station of the College and summarized below:

WEATHER DATA	SET I From July 17 to November 16, 1948	SET II From Novem- 17, 1948, to February 23, 1949	SET III From June 18 to October 13, 1949
Rainfall, in mm.			
Range	0.1–57.1	0.1–38.4	0.1–23.6
Average	5.67	3.68	5.86
Relative humidity, in per cent			
Range	63–97	52–100	60–97
Average	86.20	83.74	82.76
Wind velocity, in m.p.h.			
Range	1–10	1–15	1–7
Average	3.02	3.17	3.32
Temperature, in °C.			
Minimum			
Range	22.0–27.1	19.0–27.7	22.0–25.0
Average	23.72	21.67	23.75
Maximum			
Range	27.0–33.9	23.5–32.0	26.3–33.0
Average	29.82	27.78	30.15

Due to lack of space and for convenience, the data in the original tables for sets I and III are presented in summary tables.

DISCUSSION OF RESULTS

Conditions of the culture media

The six culture types received different treatments, and the rice plants were expected to react differently. The writer expected that the addition of horse manure to some cultures would not only increase their nutrient contents but also conserve their moisture contents, so that if water became scarce, the rice plants could draw from the reserve in the medium.

The results of the weekly determinations of the moisture contents of the culture media revealed that cultures II, IV, and VI, which were treated with horse manure, invariably contained more moisture than any of the other cultures(tables 1, 2, and 4). More-

over, as table 4 shows, the cultures which received horse manure at the rate of 87.3 tons to a hectare showed higher percentages of loss on ignition, which indicates roughly the amount of organic matter present in the media, than those that did not receive manure. Since the manured cultures contained more organic matter and moisture, they were expected to improve the growth and development of the rice plants. The experimental data, however, did not bear out this expectation.

The weather conditions that prevailed during the periods covered by the experiments, as tabulated above, show that the heaviest rains and relative humidity occurred during the first set of cultures. Rain became scarce during the second set and the lowest and highest relative humidities occurred at this time. As regards air temperature, the lowest was recorded during set II. The temperature during the first and third sets fluctuated slightly. Stronger winds occurred during the third set, although the highest recorded wind velocity took place during set II. Fortunately, the typhoon that occurred during the first set was not strong enough to damage the plants.

The rainy season cultures

The experimental data from the rainy season culture, set I, are summarized in table 1, and those for set III, in table 4.

Rate of growth. In tables 1 and 4, the two highest growth increments for each weekly measurement were arbitrarily selected and indicated by H's. The plants in the manured cultures showed higher weekly growth increments than those in the unmanured fertilized and unfertilized cultures (table 1). In general, the addition of horse manure to the culture media increased the rate of growth of the rice plants in the fertilized as well as in the unfertilized cultures.

Flowering. As shown in table 1, the use of commercial fertilizers and horse manure, either separately or in combination, seemed to have hastened the emergence of panicles. The plants in the manured fertilized soil flowered earlier than those in the unmanured fertilized soil. A comparison of the average data on the basis of the L. S. M. D. showed that plants which received both the commercial fertilizer, or fertilizers, and the manure produced panicles significantly earlier than the plants in the other cultures. Thus, it appears that horse manure when added to the soil at the rate of 48 tons to the hectare materially hastened the emergence of the panicles of the rice plants.

The addition of horse manure at the rate of 87.3 tons to a hectare increased the mean number of culms produced. As in set I, the cultures in set III treated with horse manure produced more tillers than those in the unmanured cultures. The differences, however, were insignificant. Therefore, the addition of horse manure

either to the fertilized or unfertilized media during the rainy season did not consistently increase tillering of the rice plants.

The rather heavy application of horse manure to the fertilized cultures in set III seemed to have affected adversely the flowering of the culms. Although it increased the total number of culms (table 4), the percentages of bearing culms in the manured fertilized cultures were lower than those in the unmanured fertilized cultures. Culture II, which received only horse manure, produced slightly fewer culms than culture VI. The manured fertilized cultures had plants whose very dark green leaves and delayed flowering indicated an excess of N. The application of horse manure at the rate of 87.3 tons to the hectare of fertilized soil in this experiment delayed the flowering of rice plants.

Effects on tops and roots. The effects of the various treatments on length and weight of the tops and roots were also noted (tables 1 and 4). The plants in all the cultures that received horse manure produced better tops and roots than the plants in the unmanured soils. The shorter roots in the unmanured cultures may have been due to the lower moisture contents of these cultures (table 1). This observation seems to agree with that reported by Palis (1935) who noted that the length of roots in the different sets of cultures began to decrease as the moisture content starting from the 50 per cent saturation was diminished. This author further reported that at 50 per cent saturation or lower, the yields of roots in terms of dry weight were relatively low. In the present experiments, the yields of roots in the unmanured cultures were lower than in the manured ones. On the basis of the L. S. M. D., the differences were mostly insignificant, showing that the use of horse manure did not consistently improve the height and weight of tops and the length and weight of roots.

Effects on the yield of grains. When the yields of filled and empty grains (table 1) were subjected to the analyses of variance, the weight of the empty grains was found to be insignificant and that of the filled grains, significant. On the basis of the L. S. M. D., the difference in the weight of grains was not sufficient to warrant significance. It may be concluded that the addition of organic matter to fertilized or unfertilized soil during the rainy season did not bring about significant increases in the yield of grains.

The dry season culture

In culture set II from November 17, 1948, to February 23, 1949, the dry-season culture, the plants thrived fairly well at the start because of occasional rains, but in January and February, 1949, when there was practically no rain, the plants became stunted in growth and showed chlorotic leaves. This condition was probably due to the insufficient amount of water in the soil.

As shown in table 3, the plants grew fairly well during the first three weeks, but later the rate of growth declined gradually.

Fig. 1.—Inintiw rice plants grown on fertilized or unfertilized Lipa clay loam soil with or without horse manure. Culture Ia, control; IIc, with horse manure; IIIb, with ammonium sulfate; IVd, with ammonium sulfate and manure; Va, with ammonium sulfate and superphosphate; and VIc, with ammonium sulfate, superphosphate, and horse manure. Photographed on August 3, 1949, when the plants were 45 days old.

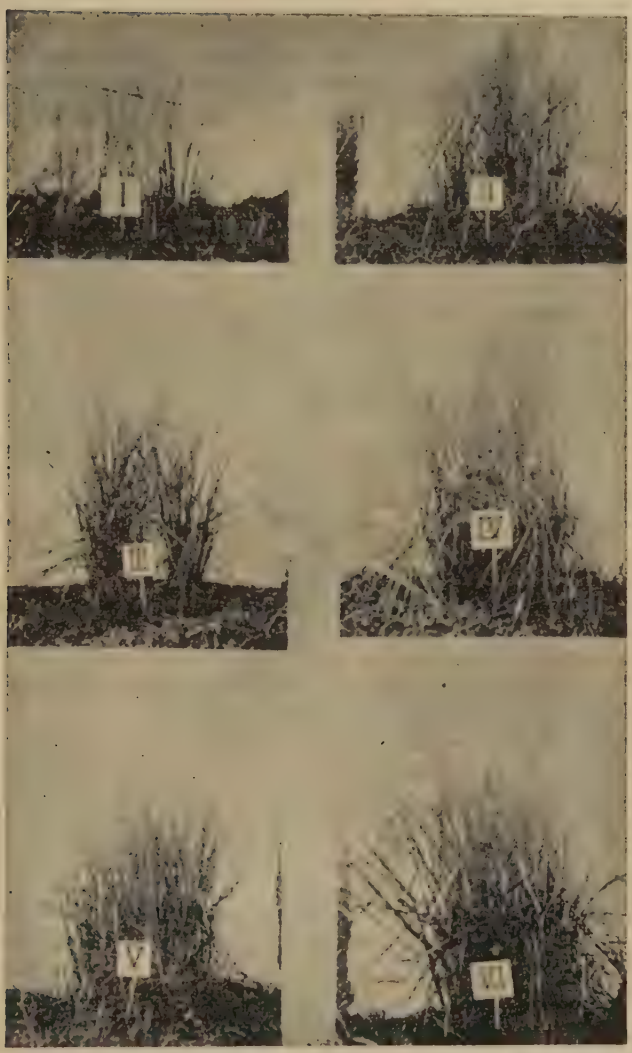

Fig. 2.—Inintiw rice plants grown on fertilized or unfertilized Lipa clay loam soil with or without horse manure. Culture I, control; II, with horse manure; III, with ammonium sulfate; IV, with ammonium sulfate and manure; V, with ammonium sulfate and superphosphate; and VI, with ammonium sulfate, superphosphate, and manure. Photographed on September 18, 1949, when the plants were 92 days old.

By January 11, 1949, there was hardly any growth of the plants, and their leaves were severely chlorotic. This was apparent in all of the cultures, although the abnormality was less in the manured cultures. All of the plants died soon, although some of those in cultures II, IV, and VI which contained manure flowered without producing grains. Under the conditions of this study, animal manure failed to provide the rice plants with enough moisture for normal growth and development.

Observations on wilting

Although all the plants wilted during sunny days, those in the unmanured pots showed the lack of water earlier than those in the manured cultures. The wilting, however, was temporary, since in the morning the plants regained turgidity. During prolonged rainless and hot periods, the tips of the leaves dried up, and most of the lower leaves drooped and dried up too (figs. 1 and 2). This condition was shown by all the three sets but more conspicuously by the unmanured cultures of set II and the manured cultures of set III. In spite of the beneficial effects of manure, the plants, except those in culture II of set III, suffered more injury than those in the unmanured and fertilized cultures, probably because the increased development of the tops also increased transpiration.

SUMMARY

1. Three sets of pot cultures to determine the effects of horse manure upon the growth and yield of upland rice, variety Inintiw, on fertilized or unfertilized Lipa clay loam soil showed that the addition of manure increased appreciably the moisture content of the soils and the rate of growth of the rice plants.

2. Horse manure, when added to Lipa clay loam, materially hastened the emergence of panicles of the rice plants.

3. During the rainy season, the addition of horse manure to the fertilized or the unfertilized soil did not significantly and consistently increase tillering of the rice plants or the yields of grains.

4. The use of horse manure did not always improve the height and weight of tops and the weight and length of roots.

5. In the dry-season cultures, animal manure failed to provide the rice plants with enough water for normal development.

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TABLE 1

Summary of observations on culture set I (Experiment from July 17 to November 16, 1948)

CULTURE NO.	CULTURE MEDIA		EXPERIMENTAL DATA, ALL AS AVERAGES								
	Treatment	Weekly moisture content	Growth increment	Number of tillers	Emergence of panicles	Height of tops	Weight of tops	Length of roots	Weight of roots	Weight of filled grains	Weight of empty grains
		per cent			*days*	*cm.*	*grams*	*cm.*	*grams*	*grams*	*grams*
I	None	29.25	—	3.0	101.3	45.5	2.8	8.0	0.87	1.1	0.48
II	Manure	34.97	2 H's	19.3	94.5	79.8	10.8	12.7	1.97	40.2	3.55
III	Ammonium sulfate	30.20	1 H	16.8	96.0	81.2	9.7	15.3	1.85	41.5	3.00
IV	Ammonium sulfate + manure	36.97	7 H's	29.5	81.3	103.1	19.3	19.0	4.97	82.9	5.90
V	Ammonium sulfate + superphosphate	30.87	2 H's	29.3	94.0	92.7	14.4	18.5	3.22	72.8	5.78
VI	Ammonium sulfate + superphosphate + manure	36.56	8 H's	36.5	80.0	112.0	19.8	19.1	3.50	85.3	5.70
	L. S. M. D.			19.22	8.19	29.04	11.41	7.79	2.16	46.91	Insig.

TABLE 2

Average weekly moisture content, in per cent, of fertilized and unfertilized Lipa clay loam with or without horse manure (Set II, from November 17, 1948, to February 23, 1949)

CULTURE NO.	WEEK ENDING								TOTAL	MEAN
	Dec. 22	Dec. 29	Jan. 8	Jan. 15	Jan. 22	Jan. 29	Feb. 5	Feb. 12		
I	38.71	—	26.35	30.72	29.35	24.80	28.94	31.02	209.89	29.98
II	43.72 H	—	27.80	31.04	33.48 H	27.97	31.32	34.29 H	229.62	32.80
III	38.28	—	27.72	31.94	30.99	29.13	29.22	32.48	219.76	31.35
IV	41.88 H	—	30.45 H	34.37 H	32.63 H	32.61 H	31.98 H	33.54 H	237.46	33.92 H
V	37.67	—	23.99	31.08	30.88	30.20	32.22 H	30.10	216.14	30.88
VI	41.49	—	29.33 H	33.50 H	32.18	30.47 H	31.73	33.51	232.21	33.17 H

TABLE 3

Mean weekly growth increments and height, in centimeters, of Inintiw rice grown on fertilized and unfertilized Lipa clay loam with or without horse manure (Set II, from November 17, 1948, to February 23, 1949)

CULTURE NO.	WEEK ENDING										HEIGHT [a]
	Dec. 7	Dec. 14	Dec. 21	Dec. 28	Jan. 4	Jan. 11	Jan. 18	Jan. 25	Feb. 1	Feb. 8	
I	1.20	2.57	4.52	3.23	1.72	1.90	1.80 H	0.33	1.40 H	0.63	25.33
II	4.55	3.21	2.82	4.13 H	3.57 H	2.85	1.85 H	0.58	0.57	0.83	30.85
III	6.85	6.64	6.29 H	1.14	1.05	2.32	0.35	0.28	0.17	0.28	31.50
IV	7.15 H	8.69 H	5.98 H	3.32	2.38	2.87 H	0.15	0.93 H	0.33	1.14 H	40.42 H
V	6.18	7.42	3.55	3.58	1.55	2.77	0.50	0.23	0.15	1.80 H	33.00
VI	7.00 H	7.67 H	3.98	5.42 H	4.50 H	3.00 H	0.75	0.80 H	0.62 H	0.48	41.97 H

[a] Average height of plants at death.

TABLE 4

Summary of observations on culture set III (Experiment from June 18 to October 13, 1949)

CULTURE NO.	CULTURE MEDIA		NUMBER OF CULMS		WEEKLY GROWTH INCREMENT	FRESH WEIGHT OF TOPS	LOSS ON IGNITION [b]	APPEARANCE OF PLANTS
	TREATMENT	*Weekly* moisture content	Flowering	Nonflowering [a]				
		per cent				*grams*	*per cent*	
I	None	36.01	13.7	2.7	—	114.75	9.86	Stunted, with chlorotic leaves
II	Manure	38.24	63.0	2.2	5 H's	543.75	12.39	Leaves were yellowish-green
III	Ammonium sulfate ..	35.18	39.5	14.7	1 H	416.75	9.29	Leaves were broad and dark green
IV	Ammonium sulfate + manure	41.23	16.7	43.2	3 H's	267.50	12.65	Leaves at the base were drooping; tips of leaves were drying up
V	Ammonium sulfate + superphosphate ...	34.95	38.7	26.0	4 H's	495.00	9.46	Leaves were broad and dark green
VI	Ammonium sulfate + superphosphate + manure	38.39	34.5	42.7	7 H's	395.25	12.49	Leaves at the base were drooping; tips of leaves were drying up

[a] The rather large number of nonflowering plants was due to the immaturity of the plants when these data were gathered.

[b] Computed on the basis of the oven-dry weight of the samples.

THE LACTATION OF BERKJALA SOWS [1]

MAURO L. RUMA

The amount and nutritive value of the milk secreted by the nursing mother and the feed given to her influence the growth, development, and vigor of the pigs in the litter. According to Smith,[2] sow's milk is 44 per cent more concentrated than cow's milk and is especially rich in growth-promoting constituents such as protein and ash. Smith also cites the observation made by Hughes and Hart that the ash of cow's milk contains 25.95 per cent calcium and 15.63 per cent phosphorus. Morrison [3] refers to Woll who found that the fat globules of sow's milk are one-fourth as large as those of cow's milk and eight times as numerous.

To have an idea of the nature of sow's milk and the amount of feed needed by a sow and her young before the latter are weaned, an experiment was conducted from November 3, 1950, to September 3, 1951, in the Department of Animal Husbandry, to determine (*a*) the amount of milk secreted by a sow during the nursing period, (*b*) the proximate analysis of the sow's milk, (*c*) the percentage number of pigs raised to weaning age, (*d*) the effect of lactation on the weight of pigs and nursing sow, and (*e*) the amount of feed consumed by the sow and the pigs during nursing.

MATERIALS AND METHODS

Eight nursing sows of the Berkjala breed and their litters were observed for eight weeks, the standard nursing period for sows. They were fed with the College standard swine ration No. 1 [4] for nursing sows, which consists of 10 parts of corn, 60 parts of fine rice bran, 20 parts of copra meal, and 10 parts of fish meal, all parts by weight. The litters were fed with the same ration in separate troughs.

To facilitate observation, each sow and her litter were kept in a hog pen with a concrete floor and an adjoining outdoor run. Rice straw was used for bedding. The nursing pigs were allowed access to the hog run during the entire nursing period.

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[1] Experiment Station Contribution No. 1620. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, October, 1951, No. 1764. Prepared in the Department of Animal Husbandry under the direction of Dr. Mariano Mondoñedo.

[2] SMITH, W. W. 1937. Pork production. Rev. ed., xxii + 575 p. New York: The Macmillan Company.

[3] MORRISON, F. B. 1945. Feeds and feeding. 20th ed., vi + 1050 p. Ithaca, New York: The Morrison Publishing Company.

[4] Anonymous. 1939. A handbook of Philippine agriculture. v + 803 p. College of Agriculture, University of the Philippines.

The sows and the pigs were weighed at the start and weekly thereafter on a Fairbanks-Morse portable scale of 750 kg. capacity, sensitive to 0.1 kg.

During the first five days after farrowing, each sow was brought to full feeding gradually. Feeding was made twice a day, at 6:00 a.m. and at 6:00 p.m. All the sows were fed with the same ration and were treated in the same manner in the pen.

The young pigs were started on concentrate four weeks after birth. They were fed in a pig-creep all the feed they could eat three times a day, at 6:00 a.m., 12 m., and 6:00 p.m. On the fourth week the feed was given in a dry form; on the fifth and sixth week, in the form of slop consisting of equal parts by weight of concentrate and water; and on the seventh and eighth week, in the form of slop consisting of one part concentrate and two parts water, all parts by weight.

The newly born pigs were separated from the mother and kept in a separate pen. The sow and her litter were brought together for nursing six times in twenty-four hours during the first week—at 6:00 a.m., 10:00 a.m., 2:00 p.m., 6:00 p.m., 10:00 p.m., and 2:00 a.m. of the following day; five times on the second and third week—at 5:00 a.m., 9:00 a.m., 1:00 p.m., 5:00 p.m., and 9:00 p.m.; four times on the fourth and fifth week—at 6:00 a.m., 12 m., 6:00 p.m., and 12 p.m.; three times on the sixth and seventh week—at 6:00 a.m., 2:00 p.m., and 10:00 p.m.; and two times on the eighth week—at 6:00 a.m. and 6:00 p.m.

The amount of milk secreted by each sow was determined by weighing the sow immediately before and after each nursing. The difference in weight represented the amount of milk secreted. To avoid defecation and urination between weighings as much as possible, the sow was let out from the pen before the first weighing.

Samples of sow's milk were taken in the early, middle, and later periods of lactation. The proximate constituents were determined in the Department of Agricultural Chemistry.

DISCUSSION OF RESULTS

Four nursing sows completed the standard eight weeks of lactation, but four did not, owing to the death of all the pigs in their litters.

For eight weeks, each sow yielded an average of 1.44 kg. of milk a day, which was about one-half the amount (2.23 to 5.32 kg.) reported by Morrison.[5] The relatively lower production of milk of the Berkjala sows might be attributed to their smaller size as compared with the breeds in the United States. The average daily amount of milk secreted the first week was 2.47 kg., which gradually

[5] Morrison, F. B. 1949. Feeds and feeding. 21st ed., vi + 1207 p. Ithaca, New York: The Morrison Publishing Company.

decreased to 0.76 kg. in the eighth week. The average daily secretion for the eight-week lactation period was 1.44 kg.

Composition of sow's milk

The sow's milk contained an average of 25.75 per cent total solids, 21.22 per cent crude fat, 4.41 per cent crude protein, 1.00 per cent nitrogen-free extract, and 0.97 per cent ash. The calorific value for every 100 grams was 212.67. Nitrogen-free extract was found only in the milk sample drawn the first week of the nursing period. Smith stated that the average composition of the milk of 53 sows, according to reports from the Wisconsin, California, and Purdue Experiment Stations, was as follows: total solids, 18.45 per cent; fat, 5.91 per cent; protein, 6.11 per cent; sugar, 5.48 per cent; and ash, 0.95 per cent. The percentages of protein and of ash in this study differ only slightly from those in Smith's figures, but the percentage of crude fat is three times more than that reported by Smith. Cow's milk has far lower percentages of nutrients than sow's milk.

Number and weight of pigs in the litter

The average number of pigs in a litter at birth was 9.25 and at weaning, 1.87; the average weight of the pigs at birth was 7.89 kg. and at weaning, 8.14 kg. The decrease in number and weight of pigs in the litter as lactation advanced was due to the unusually high mortality of pigs during the period of this study.

The average weight of a pig at birth was 0.85 kg., and after the eighth week, 4.34 kg. The total gain of each pig during the entire nursing period of 56 days, therefore, was 3.49 kg., which is comparatively lower than the figure reported by Belen.[6]

Fifteen pigs were weaned, or only 20.27 per cent of the pigs born, which is very low compared with the accepted standard average of 75 per cent reported by Mondoñedo.[7]

Changes in weight of the nursing sows

Five of the eight sows under study decreased in weight and three gained. The loss in weight was heavier during the first three weeks of nursing than during the last five weeks, probably because at that time the pigs subsisted entirely on the milk of the dams. After the third week the loss in weight decreased, and some of the sows even gained in weight, the maximum gain being obtained on the sixth week. The increase in weight was due to various factors—namely, the fact that the younger sows were still growing, the decrease in size of the litter due to death, and the increased amount of

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[6] BELEN, FELIPE C. Studies on the performance of Berkjala sows: I. Production on the first litter from farrowing to weaning. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, November, 1950. (Unpublished).

[7] MONDOÑEDO, M. 1939. Cost of producing pigs at the College of Agriculture. Philippine Agriculturist 28: 26–37.

concentrate consumed by the pigs, which reduced the amount of milk that the young sucked from the dams. The loss during the first three weeks, however, was greater than the gain during the five succeeding weeks. The loss for each sow for the entire period was 1.96 kg.

Feed consumption

During the eight-week nursing period, the average weight of the sows was 138.1 kg. The average amount of feed consumed was 135.25 kg., or 2.41 kg. of feed daily, or 1.8 per cent ration. These figures were similar to those obtained by Belen in 1950.

The average amount of feed consumed by each litter was 15.10 kg., which is more than the figure reported by Albas.[8] Of the 15.10 kg., 2.16 kg., or 14.3 per cent was consumed during the fourth week; 2.07 kg., or 13.74 per cent, on the fifth week; 2.72 kg., or 18.01 per cent, on the sixth week; 3.65 kg., or 24.1 per cent, on the seventh week; and 4.52 kg., or 29.93 per cent, on the eighth week.

To produce a kilogram gain in weight during the first three weeks of nursing, 5.48 kg. of milk and 0.78 kg. of concentrate were necessary. As the pigs grew older, they required more feed, milk and/or concentrate to produce a kilogram gain. For the entire lactation period, therefore, a kilogram gain in weight of a pig required an average of 6.42 kg. of milk and 0.78 kg. concentrate, or 7.2 kg. of both feeds, which is more than the requirement found by Ortiz.[9]

SUMMARY

1. The average amount of milk produced by a sow for the entire nursing period of 56 days was 80.59 kg., or an average of 1.44 kg. a day.

2. Sow's milk contains 25.75 per cent total solids, 4.41 per cent crude protein, 21.22 per cent crude fat, 1.00 per cent nitrogen-free extract, and 0.97 per cent ash. The calorific value of every 100 grams was 212.67.

3. The average loss in weight for each sow during the entire lactation period was 1.96 kg. The average weight of a pig at birth was 0.85 kg. and at weaning age, 4.34 kg. The percentage of pigs raised to weaning age was 20.27.

4. The amount of feed consumed by a sow for the entire nursing preiod was 135.25 kg., or 2.41 kg. a day; by the litter, 15.10 kg., or 0.43 kg. a day.

5. As much as 5.48 kg. of milk was necessary to produce a kilogram gain in weight for the first three weeks and 7.37 kg. of milk for the five succeeding weeks. For the entire nursing period, the pigs required 6.42 kg. of milk and 0.78 kg. concentrate to make a kilogram gain.

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[8] ALBAS, DOLAN. Studies on the performance of Berkjala sows: II. Second farrowing to weaning. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, April, 1951. (Unpublished.)

[9] ORTIZ, FLORENTINA C. A study on the artificial raising of newly born pigs. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1948. (Unpublished.)

COLLEGE AND ALUMNI NOTES

Dr. F. M. Fronda, professor of poultry husbandry and secretary of the College, was appointed expert on poultry production in connection with the technical assistance to be given through the Food and Agriculture Organization of the United Nations to the government of Thailand. He left by plane for Bangkok on September 14, 1951. He will advise and assist the government of Thailand in the breeding and management of poultry, in teaching poultry subjects, and in training personnel in this field. He expects to be away one year. With him are his daughters, Teresita and Aurora.

Prof. M. A. Gapud, of the Department of Agricultural Education, was designated acting secretary of the College.

Mr. Amado C. Campos, '49, of the Department of Animal Husbandry, returned by plane on August 24, 1951. He pursued studies in poultry genetics at the University of Maryland, where he was awarded a Master's degree.

The office of the secretary reports that the candidates for graduation at the end of the current semester number as follows: for the B.S.A. degree, 21; for the Certificate in Agricultural Education, 2; for the title of Associate in Agriculture, 5.

At a meeting of the Maquiling School Corporation held on August 24, 1951, the following were elected to the board of trustees: Dean L. B. Uichanco, president; Dr. F. M. Sacay, vice-president and director; Prof. M. A. Gapud, secretary-treasurer; Dr. F. O. Santos, member; and Dr. A. G. Tan, member.

Classes in catechism have been going on in the Maquiling School and the Rural High School. Members of the UPSCA are taking charge of the work under the supervision of Fr. James Collins, O.S.C.

The Rural High School senior class had an excursion to Manila on August 25, 1951. The students were accompanied by Mr. Crispin Las Marias, adviser.

The junior students held a barn dance on September 1, 1951, at the Rural High School Auditorium, under the advisorship of Mr. Martin V. Jarmin.

Headed by Mr. Francisco Ramos, adviser, the sophomores went on an educational trip to Manila on September 1, 1951.

Mr. Salvador B. Oliveros, '33, was designated acting general manager of the Philippine Sugar Institute. He was formerly assistant director of the Sugar Rehabilitation and Adjustment Commission.

Mr. Dominador Z. Rosell, '28, is the acting director of the Bureau of Soil Conservation while the director is on an official trip abroad.

Mr. Guillermo P. Santos, '48, was recently appointed acting manager of the production department of the newly recreated NARIC.

Mr. Jose M. Trinidad, '18, chief of the technical division, Department of Agriculture and Natural Resources, is conducting an observation of agriculture in Japan and the United States under the Smith-Mundt Act.

Mr. Artemio E. Gesmundo, '30, of the Cebu branch of Getz Bros. & Co., is doing excellent work, according to the manager, Mr. John M. McTeer, who desires to employ more graduates for his agricultural projects.

A committee on power alcohol, which was recently called to a meeting by the Office of Economic Coordination, was composed largely of alumni of the College. They are: Dr. Anastacio L. Teodoro, '18, chairman, Mr. Gil O. Opiana, '23, Dr. Manuel L. Roxas, '11, Professor Alejandro B. Catambay, '24, and Mr. Salvador B. Oliveros, '33. A power alcohol seminar to be sponsored by ECAFE is being planned to be held either in India or the Philippines.

Miss Dolores P. Barile, '46, a teacher of agriculture at Quezon Provincial High School, sailed on August 26, 1951, for the United States as a Fulbright scholar. She will pursue advanced studies in vocational education at the University of Illinois.

Mr. Antonio Lejano, '13, manager of the fiber inspection service, was sent abroad to make observation and study of the various phases of the fiber industry in the United States and in South and Central American countries.

Mr. Elias M. Caray, '21, superintendent of schools in Nueva Ecija, left for the United States as a Smith-Mundt scholar. He will study the American educational system.

Mr. Pedro S. Paje, '25, assistant to the Director of the Bureau of Prisons, has been appointed government pensionado to study prison industries in the United States.

Mr. Francisco R. Lopez, '36, assistant manager and in charge of the N.D.C. textile mills, has been authorized by the government to make a study of ventilating systems of textile mills in the United States.

Mr. Alfonso B. Castro, '40, joined the staff of the PHILCUSA on September 1. He was formerly principal of the Negros National Agricultural School at Kabankalan, Negros Occidental.

Mr. Jesus C. Alix, '50, has opened a private school of practical poultry farming in Cebu City. His own poultry farm serves as laboratory of the school.

Mr. Alberto B. Dalañgin, 51, has joined the faculty of Samar Junior College at Catbalogan. He teaches botany in the collegiate department and general science and horticulture in the secondary department.

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